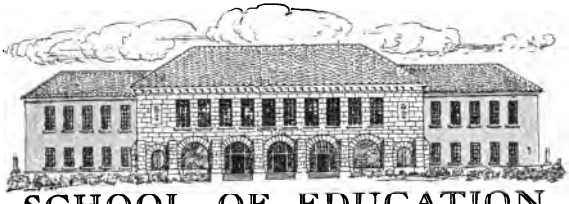

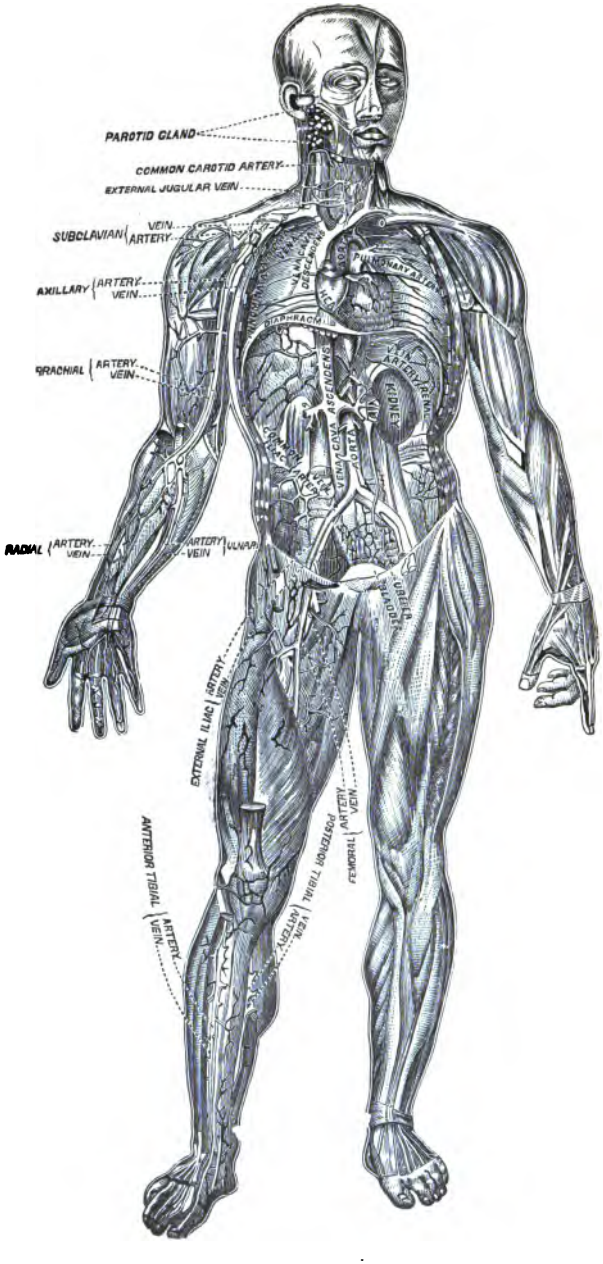
PAROTID GLAND
COMMON CAROTID ARTERY
EXTERNAL JUGULAR VEIN
SUBCLAVIAN VEIN ARTERY
AXILLARY ARTERY VEIN
BRACHIAL ARTERY VEIN
RADIAL ARTERY VEIN
ULNAR ARTERY VEIN
DIAPHRAGM
KIDNEY
EXTERNAL ILIAC ARTERY VEIN
FEMORAL ARTERY VEIN
POSTERIOR TIBIAL VEIN ARTERY
ANTERIOR TIBIAL ARTERY VEIN

INTERMEDIATE

ANATOMY, PHYSIOLOGY, AND HYGIENE,

INCLUDING

SCIENTIFIC INSTRUCTION UPON THE EFFECTS OF NARCOTICS AND STIMULANTS UPON THE HUMAN BODY.

BASED ON

CALVIN CUTTER'S

FIRST BOOK ON ANATOMY, ETC.

BY

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ILLUSTRATED.

PHILADELPHIA:

J. B. LIPPINCOTT COMPANY.

PREFACE.

It is conceded in the literary as well as the commercial world that "success is the test of merit." On this premise the "First Book on Anatomy, Physiology, and Hygiene," by Calvin Cutter, A.M., M.D., published in 1854, has been a marked success.

If the sales of a work are an index of its merit, the publishers may feel that this one has met the demand of an educated and appreciative public, since the number sold in the United States and the provinces of Ontario and Quebec has reached upwards of three hundred thousand.

In 1854, owing to the want of a teachable text-book, physiology and hygiene was not a general branch of school instruction. This book, more than any other, has served to educate the teacher and the public of this decade to the importance of hygiene and physiological school instruction.

This book in the hands of missionary laborers and native scholars has been translated and published in the Bulgarian, Armenian, Arabic, Hindustani, Tamil, Japanese, also in other Oriental dialects. It has also been prepared in raised letters for the blind.

In the Revised Edition only such portions have been rejected as do not meet the claims of advanced science. The chapters on Anatomy have been but slightly changed. Those on Physiology and Chemistry have been brought up to the present state of these sciences. The effects of Alcohol, Tobacco, Opium, etc., on the structure, functions, and health (Hygiene) of the parts of the body (particularly of young

persons) have been treated from a scientific stand-point in each chapter of this revision.

The facts have been adduced from the latest experiments and observations of medical investigators and practitioners and leading chemists, not only in this country but in Europe.

There have been added in this edition chapters on Foods, Beverages, the Home and Emergent Cases, also directions for simple experiments and for demonstrations on the living body, and for the dissection of small animals (dog, rat), illustrative of the structure and the actions of the living body. While believing that charts for reference and engravings on the printed page are indispensable to a proper study of the subject, we also think that object lessons, seeing the organ or part, and witnessing the phenomena of life, will make a more enduring impression, and should take precedence in this branch of modern science.

To instructors and the patrons of education the Revised Edition of the "First Book" is respectfully submitted.

JOHN CLARENCE CUTTER.

WARREN, MASS., August, 1887.

TO THE TEACHER.

It is suggested that the teacher carefully read the notes; that as far as possible the experiments, demonstrations, and dissections there outlined be carried out in the presence of the class; and that the management of emergent cases be repeatedly and fully practised before the pupils. The use of painted plaster models and of CUTTER'S OUTLINE ANATOMICO-ZOOLOGICAL CHARTS is also to be commended.

The apparatus needed is limited: bulb-syringe, fruit-jars, microscope, candles, a pocket-knife, a saw, a cake-knife, several small hooks in handles (made by fastening barbless fish-hooks to pen-holders), and scissors.

CONTENTS.

INTERMEDIATE
ANATOMY, PHYSIOLOGY, AND HYGIENE.

CHAPTER I.

GENERAL REMARKS.

1. **Anatomy** (a-nat'o-me) is a description of the *organs*, or parts, of a body (*a*).

Examples.—The teeth, stomach, and heart are some of the organs of the human body.

2. **Physiology** (fiz-e-ol'o-je) treats of the *functions*, in health, of all the organs.

Example.—The stomach in man is one of the organs that prepare the food for his growth. This is its function.

3. **Hygiene** is the art of preserving health, or that department of medicine which treats of the prevention of disease.

4. *The life of man is shortened by disease.* Disease is under the control of fixed laws,—laws which we are capable of understanding and obeying (*b*). How important, then, is the study of physiology and hygiene! For how can we expect to obey laws which we do not understand?

5. **Injurious Agents.**—The abuse of *tobacco* leads to

disease of the throat. The abuse of *alcohol* cripples the brain, the stomach, the muscles, and other parts of the body. The steady use of *opium* (given to children in "soothing syrups") injures the action of the stomach.

(*a*) **FOR THE TEACHER. Directions for General Demonstrations.**—Select a well-formed boy. Request him to remove most of his outer garments, and then to stand before the class. Point out, designate the limits, and name the following:

1. *Parts of the Body:* (*a*) head, neck, trunk; (*b*) arms (right and left) and limbs.

2. *Parts of the Head:* the movable scalp covering the unsymmetrical skull-cap (no two heads are exactly alike), face, external ear (showing the external pinna, the external canal studded with wax-glands and stiff hairs and a collection of wax).

3. *Parts of the Face:* (*a*) forehead, temples, cheeks, cheek-bones, chin, mouth, movable lower jaw; (*b*) nose, bridge of nose, nostrils; (*c*) eyes, eyebrows, eyelids, eyelashes, puncta, the lining mucous membrane, the ducts ending on the edge of the eyelid; (*d*) mouth, lips, mucous membrane, teeth, tongue.

4. *Parts of the Neck:* nape, larynx (Adam's apple), the pulsating carotid artery, the outer, blue veins, trachea. Turn the head and throw the head back, the front border of the prominent muscle running from the ear downwards and forwards marks the course of the carotid.

5. *Parts of the Trunk:* (*a*) thorax (the ribbed portion with the central sternum), abdomen, pelvis; (*b*) shoulders, spine (the median furrow, the prominences of the vertebræ), collar-bone, ribs, hips.

6. *Arms:* (*a*) axilla (armpit) with its throbbing artery, arm, forearm, wrist, hand, palm of hand, fingers; (*b*) joints: shoulder, elbow, point of elbow, wrist, "pulse at wrist," tendons, finger; (*c*) the varieties of motion at each joint.

7. *Hand:* (*a*) palm, back, fingers, knuckles, beating artery inner side of finger nails; (*b*) fingers: index, middle, ring, little; (*c*) thumb.

8. *Limbs:* (*a*) thigh, patella, hamstrings, leg (shin and calf), ankle, tendon of Achillis (above heel), foot; (*b*) sole, instep, heel, ball, toes, arches (make an impress in soft clay or plaster of Paris of the bottom of the foot, in order to show the two arches); (*c*) the varieties of motion at each joint.

9. *Symmetry:* Drop a plumb-line in front of the centre of the forehead. Call attention to the right and left halves of the body; to the right and left parts in succession from above downwards; to the right and left apertures of the head (mouth excepted).

10. Require the members of the class to demonstrate the parts on the boy, naming the parts as they are indicated.

(*b*) If statistics may be trusted, modern hygiene has added so much to English longevity that men (1884) live two years and women three years and four months longer than they did thirty years ago. In the aggregate the improvement is six per cent.

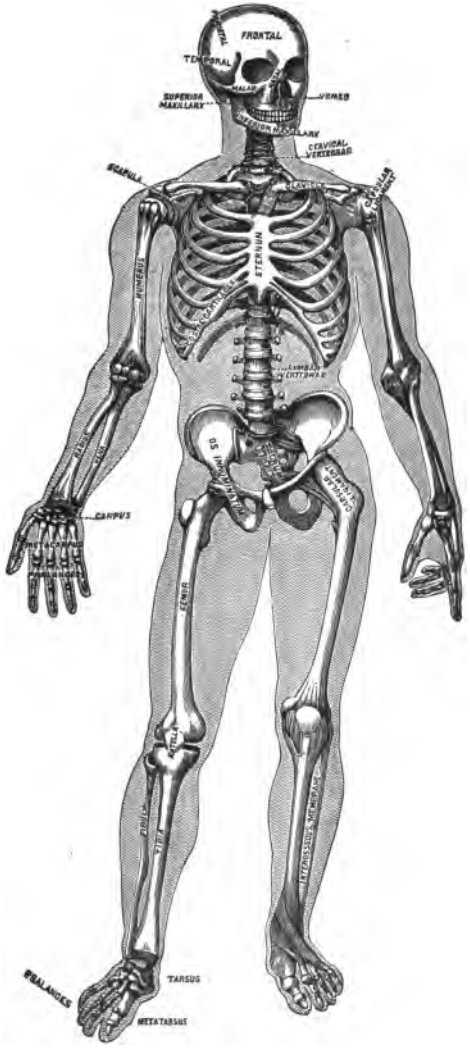
FRONTAL
TEMPORAL
SUPERIOR MAXILLARY
HUMERUS
INFERIOR MAXILLARY
CERVICAL VERTEBRAE
SCAPULA
CLAVICLE
STERNUM
RIBS
DORSAL VERTEBRAE
ULNA
RADIUS
CARPUS
OS INNOMINATUM
SACRUM
FEMUR
PATELLA
TIBIA
FIBULA
INTEROSSEOUS MEMBRANE
PHALANGES
TARSUS
METATARSUS

FIG. 2

CHAPTER II.

THE FRAMEWORK.

6. The Bones held together by ligaments make up the framework of the human body. The bones are hard and firm, and of a pinkish-white color.

Observation.—In all the higher orders of animals, among which is man, they are in the interior of the body. In the lower the framework is, as a rule, outside.

ANATOMY OF THE BONES.

7. Bones.—There are two hundred bones in the human body, beside the teeth. These, for convenience, are divided into four classes: 1st. The bones of the *Head.* 2d. The bones of the *Trunk.* 3d. The bones of the *Upper Extremities.* 4th. The bones of the *Lower Extremities.*

HEAD.

8. The Bones of the Head are divided into those of the *Skull* and *Face.* (Fig. 3.)

9. The Skull is formed of eight bones. Some are joined together by ragged edges, called *su'tures.* (Fig. 3, between [1] and [2, 2] and [3, 3] and [4].)

Observation.—The sutures stop, in a measure, the jars caused by external blows. Children should never strike each other upon the head, because the bones of the skull in them are softer than in adults.

10. In the **Face** are fourteen bones. They support the softer parts outside of them. (Fig. 3, [5, 6, 7, 8, 9].)

FIG. 3. BONES OF THE HEAD.—1, Frontal bone. 2, Parietal bone. 3, Temporal bone (containing the ear-bones). 4, Occipital bone. 5, Nasal bone. 6. Malar bone. 7, Upper jaw. 8, Lachrymal bone. 9, Lower jaw.

TRUNK.

11. **The Trunk** has fifty-four bones,—twenty-four *Ribs;* twenty-four bones in the *Spi'nal Col'umn* (backbone); four in the *Pel'vis;* the *Ster'num* (breastbone); and one at the root of the tongue (*Hy'oid*).

12. All the **Ribs** are joined to the spinal column. There are twelve on each side. (Fig. 4.) The seven upper ribs are united in front to the *sternum* (Fig. 4, [2]) by a yielding substance called *car'ti-lage* (gristle). Three are joined to each other by long cartilages; two are not confined; hence they are called "floating ribs."

13. Chest.—The cavity formed by the sternum, ribs, and spinal column is called the *Chest.* It contains the heart, lungs, and large blood-vessels.

Observation.—The *shape of the chest* is conical, or like a sugar-loaf. The lower part of the chest is broader and fuller than the upper part, when it is not made smaller by snugly-fitting clothing. (Fig. 4.)

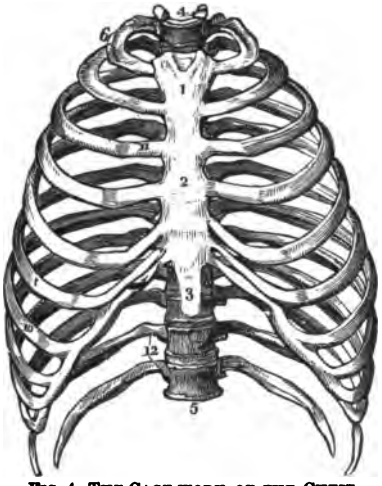

FIG. 4. THE CAGE-WORK OF THE CHEST.—1, 2, 3, The sternum (breastbone). 4, 5, The spinal column (backbone). 6, The first rib. 10, The seventh rib. 11, The cartilage of the third rib. 12, The floating ribs.

14. The Spinal Column is composed of twenty-four pieces of

FIG. 5. A VERTEBRA.—1, The cartilage that connects the vertebræ. 3, 4, 5, 6, Processes, or projections. 7, Opening for spinal cord.

bone. Each piece is called a *ver'te-bra.* (Fig. 5.) Between every two vertebræ is a thick piece of cartilage, which is elastic like india-rubber. This not only unites the vertebræ, but permits them to move in different ways. (Fig. 5, [1].)

15. Spinal Canal.—There is an opening in each ver-

tebra. (Fig. 5, 7.) By the union of these openings a canal is formed the whole length of the spinal column, in which the *spinal cord* is placed. (Fig. 49.)

16. *The spinal column is a very curious and perfect piece of mechanical art.* By its structure, great strength and sufficient movement or flexibility are combined.

17. **The Pelvis** is composed of four bones. They are so arranged as to form a bony basin. The spinal column rests on these bones. In the erect posture the pelvis rests on the lower extremities. The two *ossa innominata*, the *sacrum*, and the *coccyx* (Fig. 2) form the pelvis.

CHAPTER III.

THE FRAMEWORK—Continued.

THE UPPER EXTREMITIES.

18. **The Upper Extremities** contain sixty-four bones,—the *Scap'u-la* (shoulder-blade), the *Clav'i-cle* (collar-bone), and the bones of the *Arm*, *Forearm*, *Wrist*, and *Hand*.

19. **The Scapula** is a broad, irregular bone, situated upon the upper and back part of the chest. (Fig. 2.)

20. **The Clavicle** is a thin bone at the base of the neck. It is joined at one extremity to the sternum, at the other to the scapula. (Fig. 2.)

21. The use of the clavicle is to keep the arms from sliding towards the breast. Children should frequently throw their arms backward, as this exercise will tend

to increase the length of this bone, and also to enlarge the chest.

22. **The Arm** is formed of a single bone, called the *hu'mer-us.* (Fig. 2.)

23. **The Forearm** is formed of two bones,—the *ul'na*, on the inner side, and the *ra'di-us*, on the outside (the side on which the thumb is placed). By a beautiful arrangement of these bones, the hand can *rotate*, or turn. (Fig. 2.)

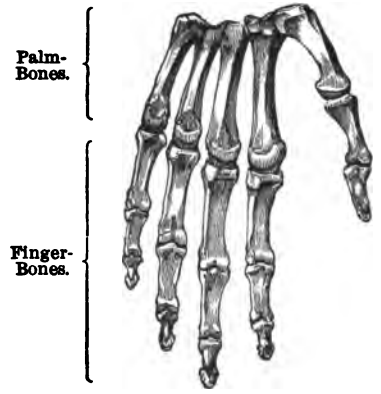

FIG. 6. THE BONES OF THE HAND.

24. **The Wrist** is formed of eight irregular bones. They move but little upon each other. (Fig. 2, CARPUS.)

25. **The Hand** consists of nineteen bones,—five in the palm, and fourteen in the fingers and thumb. (Fig. 6.)

26. **The Thumb** has but two bones. It is readily opposable to each of the fingers.

THE LOWER EXTREMITIES.

27. **The Lower Extremities** contain sixty bones,—the *Fe'mur* (thigh-bone), the *Pa-tel'la* (knee-pan), the *Tib'i-a* (shin-bone), the *Fib'u-la* (small bone of the leg), and the bones of the *Foot.*

28. **The Femur** is the longest bone of the body. It

supports the weight of the head, trunk, and upper extremities. (Fig. 2.)

29. **The Tibia** and the **Fibula** are situated between the knee and ankle. (Fig. 2.)

30. **The Foot** is formed of twenty-six bones,—seven in the instep, five in the middle of the foot, and fourteen toe-bones.

Observation.—The bones of the foot are so united as to give it the form of an arch,—convex on its upper surface, and concave on its lower surface. (Fig. 7.)

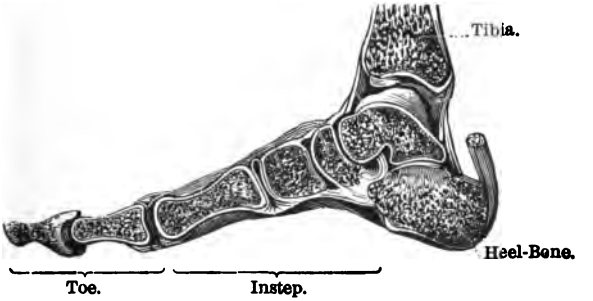

FIG. 7. A SIDE VIEW OF THE BONES OF THE FOOT, SHOWING ITS ARCHED FORM.—The arch rests upon the *heel* behind, and the *ball* of the toes in front.

31. **Composition of Bone.**—The bones consist of animal matter (jelly) and earthy matter (phosphate and carbonate of lime) and other minerals (*a*).

THE JOINTS.

32. **The Joints** are composed of the extremities of two or more bones,—*Car'ti-lages* (gristles), *Sy-no'vi-al Mem'brane*, and *Lig'a-ments* (*b*).

33. Cartilage is a smooth, solid, elastic substance, that covers the ends of the bones that form a joint. It prevents the ends of the bones from wearing off, and also

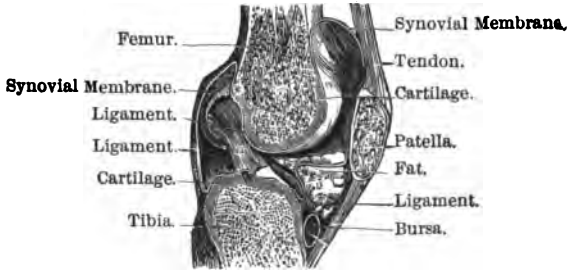

FIG. 8. VERTICAL SECTION OF THE KNEE-JOINT.

diminishes the jar that the joint receives in walking or leaping. (Fig. 8.)

34. The Synovial Membrane is a thin layer lining the inner surface of the ligaments of a joint. (Fig. 8.) It secretes an oily fluid.

35. The Ligaments are strong, inelastic substances. They serve to connect and bind together the bones of the body. (Fig. 8.)

INJURIOUS AGENTS.

36. Tobacco appears to interfere with the proper growth of the bones of children who use it in any form.

37. Alcohol is found to hinder the making of healthy bones in children. The recovery from *rheumatism* (rū'matizm) is delayed by the use of beer, cider, and sweet wines.

(a) FOR THE TEACHER. Take a long bone, as a sheep's rib, and put it in a vessel containing one part of muriatic acid and seven parts of water. Allow it to

remain a few days. The earthy matter will be mostly dissolved out. The bone will now be flexible, and may be knotted. Place another bone in the fire. The animal matter is expelled, and the brittle "bone-earth" alone is left.

(*b*) **Demonstration of a Joint.**—Procure the lower portion of the hind-limb of a dog, pig, or calf. Remove all muscle, fat, and connective tissue from about the joint. Observe the lateral, anterior, and posterior *ligaments*, if it is a "hinge-like joint." Saw the bone off about two inches below the joint. Then saw through the middle of this bone, the joint, and the upper bone, laying open the parts, as in Fig. 8. Note the investing membrane, the *periosteum;* the *compact* bone; the *cancellated* or open-work bone, near the joint; the soft, red, oily *marrow;* the *enlargement* and *processes* for muscular and ligamentous attachment near the joint; the *cartilage* tipping the bone; the lateral firm, white, band-like *ligaments;* the white, viscid *synovial fluid;* and, perhaps, an internal *round* ligament, *movable cartilage*, and a mass of *fat*. Cut the lateral ligaments. Observe the smooth, moist surface of the ligaments, the internal layer of *synovial membrane*. Shave off a bit of bluish-white, translucent cartilage, and compare it with a bit of bone.

CHAPTER IV.

PHYSIOLOGY OF THE BONES AND THE JOINTS.

38. *The bones are the framework of the body.* They support all the soft parts, as the flesh and vessels, and likewise afford a firm surface for the attachment of the ligaments.

39. *The use of the various bones is different.* Some protect organs, as those of the skull and chest, while others are used when we move, as those of the extremities and spinal column.

40. The bones are covered with a fine membrane or skin called *per-i-os'te-um.* When pus collects between the periosteum and the bone, as in a "felon," then the pain is very acute, for the pus cannot get out.

41. The joints are constantly supplied with a fluid called Sy-no'vi-a. This operates like oil on the bearings

of a machine. By the *smooth cartilages* and *synovia*, the joints are enabled to bear all the motion required of them during a great number of years.

42. *The joints vary in their functions.* Some are movable, as the finger-joints, while others are immovable, as the sutures of the skull.

43. *The union of the spinal column with the skull* exhibits one of the most ingenious contrivances to be met with in the body. It permits (1) the backward and forward movement, as in bowing and nodding the head; (2) the motion which is made in turning the head from side to side.

44. **Kinds of Joints.**—Some joints move but in one direction, like a hinge of a door. These are called *Hinge-Joints*, as the ankle- and the knee-joint. Some joints move in different directions, like a ball in a socket. These are called *Ball-and-Socket Joints*, as the shoulder- and the hip-joint.

Observation.—The more movable a joint, the less firm it is, and the more frequently dislocated, or "put out." It is for this reason that the shoulder-joint is more frequently displaced than any other in the body.

ACTION OF ALCOHOL.

45. **Gout.**—The free use of *wines*, together with rich food, often brings on gout. *Beer-drinking* is a great cause of gout among the poor of London.

46. **Alcohol** injures bone-growth and bone-health by being present in the blood and preventing healthy feeding of the bones.

CHAPTER V.

HYGIENE OF THE BONES.

47. *The bones require exercise to make them healthy.* By use they are increased in size and strength to a limited extent, while inaction or disease weakens them.

48. *The exercise or labor should be adapted to the condition of the bones.* The bones of a child contain more of the animal than of the earthy matter, and are consequently weak; though the child is able to exercise, its bones are not adapted to severe toil. On the other hand, the bones of the aged man contain relatively more earthy than animal matter. This causes them to be brittle and unfit for severe labor.

49. *The clothing should be loosely worn.* The ribs and bones of the spinal column are soft and yielding in childhood. A small amount of pressure on the walls of the trunk will lessen the size of the chest, and thus injure the lungs, stomach, and heart. (Fig. 9.)

Observation.—An anxious mother consulted the celebrated surgeon Cline as to what she should do to prevent her daughter from being deformed. He answered, "Let her have no stays, and let her run about like the boys."

50. *In sitting, the feet of the child should be supported.* When the feet are not supported, the child is inclined to lean forward, contracting an injurious and ungraceful posture.

51. *Children should stand and sit erect.* This posture tends to keep the spinal column erect and healthy. When a slight curvature of the spine exists, it can be improved by walking with a book or a heavier weight upon the top of the head, to balance which the spine must be nearly erect. Those people that carry their burdens upon their heads seldom have crooked spines.

FIG. 9. A CHEST FASHIONABLY DEFORMED.

FIG. 10. A REPRESENTATION OF A DEFORMED SPINAL COLUMN.

52. *The shoes* should afford plenty of room all around the foot. The sole should be thinnest and narrowest at the "waist," where elasticity is wanted; broad and thick at the "tread," where protection is most required; long, so as not to limit the foot-extension, for the foot is slightly

lengthened with every step, and especially in running or jumping; and broad, in order not to crowd the toes. The heels ought to be low and broad.

INJURIOUS AGENTS.

53. *Alcohol and tobacco do not make bone or ligament stronger.* They do act to injure the vigor and strength of the young who use them.

54. *Beer, cider, wine, and spirits should certainly not be used by the young.* It would be better for the health of the people if they were not used by adults.

GENERAL REVIEW QUESTIONS.

General Remarks.

Define Anatomy, Physiology, and Hygiene. (1–3.) What influences the duration of life? (4.) Mention some injurious agents. (5.)

Anatomy of Bones.

Speak of the framework of the body and of bone. (6.) Describe the bones of the head. (8–10.) Describe the framework of the chest. (11–13.) Speak of the spinal column and pelvis. (14–17.) Name the upper-extremity bones, and give their relative positions. (18–26.) How is the lower extremity made up? (27–30.) Describe a joint. (32–35.) State the influence of alcohol and tobacco on bone-structure. (36, 37.)

Physiology of Bones.

Mention the uses of the bones. (38, 39.) What may be said of the periosteum? (40.) What enables a joint to work well and long? (41, 42.) Describe a remarkable joint. (43.) What joints are most frequently dislocated? (44.) How does alcohol influence bone-nutrition? (45, 46.)

Hygiene of Bone.

Speak of bones in relation to exercise. (47, 48.) Why was Dr. Cline's advice excellent? (49.) Why should the feet be supported? (50.) How may incorrect postures be corrected? (51.) Mention essentials in shoe-construction. (52.) What is the influence of alcohol, or of tobacco, on the youthful framework? (53, 54.)

BLACKBOARD ANALYTIC SUMMARY OF THE FRAMEWORK.

(Chapters II.–V.)

TABLE OF THE BONES.

- **Head (22)**
  - *Skull* (8)
    - Frontal (forehead).
    - 2 Temporal (temples).
    - 2 Parietal (side).
    - Occipital (posterior base).
    - Sphenoid (base).
    - Ethmoid (base of nose).
  - *Face* (14)
    - 2 Superior Maxillæ (upper jaw).
    - 2 Nasal (bridge of nose).
    - 2 Malar (cheek).
    - 2 Lachrymal (corner of orbit).
    - 2 Turbinated (within nostrils).
    - 2 Palate (posterior hard palate).
    - Vomer (nasal partition).
    - Inferior Maxilla (lower jaw).
- **Cervical Region** (8)
  - 7 Cervical Vertebræ (neck).
  - Hyoid Bone (base of tongue).
- **Thorax** (37)
  - 14 True, 6 False, 4 Floating Ribs
  - 12 Dorsal Vertebræ (back).
  - Sternum.

- **Upper Extremities (64)**
  - *Shoulder*
    - Clavicle (collar-bone).
    - Scapula (shoulder-blade).
  - *Arm*
    - Humerus (arm).
    - Radius, Ulna (forearm).
  - *Hand*
    - 8 Carpal (wrist).
    - 5 Metacarpal (hand).
    - 14 Phalanges (fingers).
- **Lumbar Region (5)** — 5 Lumbar Vertebræ (loins).
- **Pelvis (4)**
  - 2 Ossa Innominata.
  - Sacrum.
  - Coccyx.
- **Lower Extremities (60)**
  - *Thigh* — Femur.
  - *Leg*
    - Patella (knee-pan).
    - Tibia (large bone).
    - Fibula (outer bone).
  - *Foot*
    - 7 Tarsal (instep, heel).
    - 5 Metatarsal (arch).
    - 14 Phalanges (toes).

- **The Skeleton**
  - ANATOMY OF
    - Bones.
    - Periosteum.
    - Ligaments.
    - Cartilage.
    - Synovia.
  - PHYSIOLOGY OF
    - Framework.
    - Leverage.
    - Protection.
  - HYGIENE OF
    - Exercise.
    - Proper positions.
    - Absence of compression.
    - Proper foods.
  - AVOIDABLE CAUSES OF ILL HEALTH
    - Alcoholic structural changes.


OCCIPITO FRONTALIS
ORBICULARIS PALPEBRARUM
ORBICULARIS ORIS
MASSETER
PLEXOR CARPI RADIALIS
DELTA
BICEPS
TRICEPS
EXTENSOR CARPI RADIALIS
EXTENSOR CARPI ULNARIS
ANNULAR LIGAMENT
BICEPS FEMORIS
SEMITENDINOSUS
SEMIMEMBRANOSUS
GASTROCNEMIUS
SOLEUS
TIBIALIS ANTICUS
TENDO ACHILLIS
ANNULAR LIGAMENT

FIG. 11.

CHAPTER VI.

THE MUSCLES.

55. Body-Movements.—All the great motions of the body are caused by the movement of some of the bones which form the framework of the body; but these of themselves have not the power of motion, and only change their position through the action of other organs attached to them, which, by contracting, or shortening, draw the bones after them. In some of the slight movements, as the winking of the eye, no bones are displaced, or moved. These moving, contracting organs are the *Mus'cles* (lean meat).

ANATOMY OF THE MUSCLES.

56. A Muscle is composed of many little strings, called *fi'bres*. The fibres are made up of *contractile particles*, or cells. Some of these fibres run in straight lines; others spread like a fan, while some are arranged circularly, as around the mouth.

57. Tendon.—Towards the extremities of a muscle the fibres end in a substance of a whitish color, harder and tougher than the muscle (*a*). This is called *ten'don* (cord, sinew). (Fig. 8.)

58. *Tendons have various shapes.* Sometimes they are

long, slender cords; sometimes they are short and thick; again, they are thin and broad. They serve to fasten the muscles to the bones.

Observation.—In some instances the sheath of the tendons is ruptured, and its synovial fluid escapes. This forms a tumor, called a *gan'gli-on* (weeping sinew).

59. Layers of Muscles.—In some parts of the body there is but one layer of muscle over the bones; in other parts there are five or six layers, one muscle being placed over another. They are separated by a thin, whitish membrane, called *fas'ci-a.*

Observation.—The fascia is the membrane which envelops a leg of beef, and which is observed on the edges of a slice when it is cut for broiling.

60. Muscles, as a rule, are arranged in pairs, one on the right and one on the left side of the body. The muscles form about two-fifths of the weight of the body. (Fig. 11.)

61. The Fat of the body is made up of collections of roundish sacs, filled with an oily fluid. In health it is found in most parts of the body.

Observation.—When we are sick, and cannot take food, the body is fed with this fat. The removal of it into the blood causes the sunken cheek, hollow eye, and prominent appearance of the bones after a severe sickness.

INJURIOUS AGENTS.

62. Alcoholics, used constantly and for long times, often cause the fibres of muscles to change to *fat.* Fat

cannot contract. Hence a fatty muscle becomes feeble and flabby.

63. Tobacco and Opium.—Of the effect of these agents on the structure of muscle nothing definite is known.

(*a*) FOR THE TEACHER.—The pupil can examine a piece of boiled beef, or the leg of a fowl, and see the structure of the fibres and tendons of a muscle, with the attachment of the tendons to the bones. With a microscope magnifying 350 to 500 diameters, and a minute bit of lean meat, picked to pieces in a drop of water, the structure of muscular fibre may be made out. The fibres of "lean meat" have minute cross-marks (Fig. 12), while the fibres from the muscle of the intestine or stomach do not show the cross-markings. The former (cross-marked) are called *voluntary*, for they are largely under the control of the will; the latter (*non*-striated, or non-marked) *involuntary*, for they are not under the control of the will.

When the heart of an old cow, and especially of the short-horn breed, is examined, not infrequently the heart-muscle appears yellowish white, and exhibits a diminution in consistency and elasticity. Microscopic examination shows that the contractile muscle-cells have changed to inert fat (*fatty degeneration*).

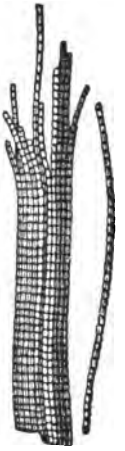

FIG. 12. THE CROSS-MARKED FIBRES OF A MUSCLE (highly magnified).

CHAPTER VII.

PHYSIOLOGY OF THE MUSCLES.

64. *Every motion of the body is made by the contraction of the fibres of the muscles.* The muscles and tendons are to the bones what the ropes are to the sails and yards of a ship. By their action the direction of the sails and yards is changed. So, by the action of the muscles, the position of the bones of the body is changed.

65. Contractility.—The power of self-shortening (*con-*

tractility) is a property of living muscle, as yellowness is of gold. The muscles receive from the nervous system (422) an *impulse*, and they contract. When the impulses cease, the muscular fibres relax and lengthen out.

66. *Muscles remain contracted but a short time;* then they relax or lengthen, which is their rest. When the muscles are in a state of contraction, they are full, hard, and more prominent than when relaxed (*a*).

67. **Voluntary Movements.**—The work of the body is largely muscle-work. The muscles of the *limbs* enable us to walk, run, etc.; those of the *pelvis and trunk*, to sit erect, to bend forward, or from side to side; those of the *chest*, to move the arms and body; those of the *arms and hands*, to perform the varying duties of life; those of the *neck*, to move the head; those of the *mouth and lower jaw*, to crush and divide the food, and to aid in speech; and those of the *face and skull*, to give expression to the countenance. All these muscles are more or less under the control of the will (*vol'untary muscles*).

68. **Involuntary Movements.**—The muscles of the *iris* (537) regulate the amount of light entering the eye; those of the *throat*, *gullet*, *stomach*, and *intestines* move the food along, and facilitate digestion; those of the diaphragm (di'a-fram) enable us to breathe; those of the *heart* force the blood to all parts of the body; those of the *blood-tubes* regulate the flow of blood; and those of the *gland-ducts* force the secretions along. These muscles are not under the control of the will (*involuntary muscles*).

69. **Conditions for Muscle-Work.**—The blood must

bring abundant supplies of *oxygen*. Hence good air must be breathed, and the chest and ab-do'men should not be compressed.

The blood must contain suitable muscle-foods. Experience shows that fatty and starchy foods are suitable for long, hard, muscular work; that lean meats are not so essential, yet they should be provided.

The blood must be freed from tissue-wastes. Every contraction produces a little wear and a little waste. The latter must be soon removed, or harm will result. Hence the skin, bowels, and kidneys must work freely.

INJURIOUS AGENTS.

70. *Alcohol in the blood prevents the ready casting out of muscle-wastes.* It is an inferior food for muscle-feeding.

Alcohol, in large doses, causes the muscles to work improperly and out of their proper order. This is seen in the uncertain actions of intoxicated persons. Large amounts cause entire loss of control over the voluntary muscles ("dead-drunk" state).

71. *Tobacco, when taken freely by the young, may cause vomiting, muscle-weakness, and trembling.* When used constantly by the young, it not uncommonly causes a weak, irregular action of the heart ("tobacco-heart"), improper action of the muscles of the eyes, and a tremor of the muscles of the arm and hand.

Observation.—Prof. Oliver, of the Naval Academy (U. S.), states that he can invariably recognize the user of tobacco from his tremulous hand and absolute inability

to draw a clean, straight line. Draughtsmen have been obliged to abstain from the use of *coffee* because of the muscular tremor occurring whenever it was drank.

72. *Opium acts especially badly upon the muscles of the intestines, blood-vessels, and heart.* The continuous use of opium (as in "Soothing Syrup") leads to a "locking up of the bowels" and a damming back in the blood of the wastes of the system.

(*a*) **Experiment.**—The alternate contraction and relaxation of the muscles may be shown by the following experiment:

Clasp the forearm about three inches below the elbow, then open and shut the fingers rapidly, and the swelling and relaxation of the muscles on the opposite sides of the arms, alternately with each other, will be felt corresponding with the movement of the fingers. While the fingers are bending, the inside muscles swell, and the outside ones become flaccid; and, while the fingers are extending, the inside muscles relax, and the outside ones swell. The alternate swelling and relaxation of opposing muscles may be felt in all the movements of the limbs.

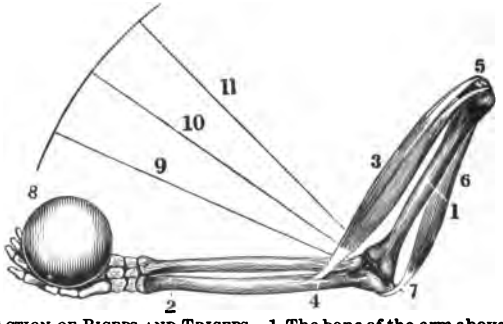

FIG. 13. ACTION OF BICEPS AND TRICEPS.—1, The bone of the arm above the elbow 2, One of the bones below the elbow. 3, The muscle that bends the elbow. This muscle is united, by a tendon, to the bone below the elbow (4); at the other extremity, to the bone of the shoulder (5). 6, The muscle that extends the elbow. 7. Its attachment to the point of the elbow. 8, A weight in the hand to be raised. The central part of the muscle (3) contracts, and its two ends are brought nearer together. The bones below the elbow are brought to the lines shown by 9, 10, 11. The weight is raised in the direction of the curved line. When the muscle (6) contracts, the muscle (3) relaxes, and the elbow is extended.

CHAPTER VIII.

HYGIENE OF THE MUSCLES.

73. *The muscles should be used and then rested.* This will increase their size and strength, by increasing the flow of blood to the parts called into action. A muscle should not be used too long or remain at rest too long; both are alike injurious.

Illustration.—Let the student leave his books and wield an iron sledge, and the muscles of his arm will increase in size and firmness. On the other hand, let the blacksmith assume the student's vocation, and the muscles of his arm will become soft and less firm.

74. *Exercise should be regular and frequent.* It is no more correct that we devote several days to a *proper* action of the muscles, and then spend one day inactively, than it is to take a *proper* amount of food for several days, and then withdraw this supply for a day.

75. *Every part of the muscular system should have its appropriate share of exercise.* Some employments call into exercise the muscles of the upper limbs, as shoe-making; others the muscles of the lower limbs; still others the muscles of both upper and lower limbs with those of the trunk, as farming. Those trades and kinds of exercise are most salutary in which all the muscles have their due proportion of action, as this tends to develop and strengthen them equally.

76. *The proper time for exercise should be observed.* As a general rule, the morning, when the air is pure, is better than the evening. We should avoid severe exercise and labor immediately before and after eating a full meal, for the energies of the system are then required to perform the digestive function.

77. *The muscles should be exercised in the light.* Light, particularly that of the sun, exercises as great an influence on man as it does on plants. Students should take their exercise during the day, rather than in the evening; and the farmer and the mechanic should avoid night toil, as it is much more exhausting than the same effort during daylight.

78. *Every muscle should move freely.* Compression by any means lessens the size and strength of the muscle. Compression by close dresses weakens the muscles of the trunk and hips (49).

79. *The state of the mind affects muscular contraction.* A person who is cheerful and happy will do more work and with less fatigue than one who is peevish and unhappy.

Illustration.—A sportsman will pursue his game miles without fatigue, while his attendant, not having any mental stimulus, will become weary.

80. **Effect of Exercise.**—The *voluntary muscles* become heavier. Up to a certain point, peculiar to each person, their strength increases with the work demanded of them. The capacity for endurance is increased. The muscles acquire ability to contract with greater rapidity and precision. The *involuntary muscles* (under continued regu-

lated exercise), especially those of the stomach, intestines, heart, and blood-tubes, appear to gain in power.

FIG. 14. CORRECT ATTITUDE.—1, A perpendicular line from the centre of the feet to the upper extremity of the spinal column, where the head rests. 2, 2, 2, The spinal column, with its three natural curves.

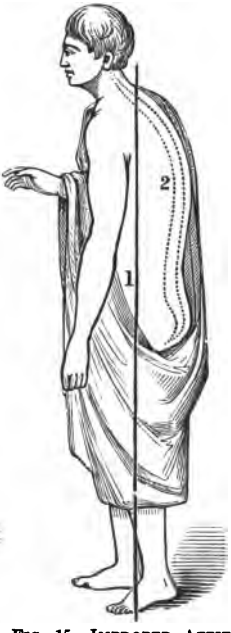

FIG. 15. IMPROPER ATTITUDE.—1, A perpendicular line from the centre of the feet. 2, Represents the unnatural curved spinal column and its relative position to the perpendicular (1). The lower limbs are seen curved at the knee, and the body is stooping forward.

81. *A person will stand longer, walk farther, and do more work when erect than in a stooping posture*, because the muscles of the back in stooping are in a state of tension, or stretching, to keep the head and trunk from falling

forward. (Fig. 15.) In the erect position the head and trunk are nicely balanced and supported by the bones of the spinal column, and the muscles of the back are called but slightly into action. (Fig. 14.)

82. *While studying, drawing, writing, and sewing, the body should be kept erect.* This attitude favors a healthy action of the various organs of the body and conduces to beauty and symmetry of form. On the contrary, narrow chests, "hollow stomachs," "round shoulders," and ill health follow a violation of this rule.

Observation.—Students are advised to do most of their studying while standing, as before a box placed on the table.

CHAPTER IX.

HYGIENE OF THE MUSCLES—Continued.

83. *Muscles should be gradually called into action.* When the muscular system has been in a state of rest, it should not suddenly be called into vigorous action. Hence start out at a slow pace, even when in haste.

84. *Muscles should be rested gradually when they have been vigorously used.* If a person has been making great muscular exertion, as in cutting wood, or any other employment, instead of sitting down to rest, he should continue muscular action by some moderate labor or amusement.

Observation.—In cases where severe action of the muscles

has been endured, bathing and rubbing the skin over the joints that have been used are of much importance. This will prevent soreness of the muscles and stiffness of the joints.

85. *Rest is essential at frequent intervals.* It enables the blood to remove the wastes from nerve and muscle, and it permits these parts to lay up new stores of oxygen. It must be of such a length as will enable the muscles to regain their tone and later to work with ease and vigor. Untrained muscles demand more frequent and longer rests than trained ones.

86. *When riding in cars and coaches the system will not suffer so severely from the jar if the muscles are slightly relaxed.* When riding over uneven places in roads, rising slightly upon the feet diminishes the shock occasioned by the sudden motion of the carriage. The muscles, under such circumstances, are to the body what elastic springs are to a carriage.

87. *Repetition of muscular action is necessary.* To render the action of the muscles complete and effective, they must be called into action repeatedly and at proper intervals. This education must be continued until not only each muscle, but every fibre of the muscle, is fully under the control of the nerve-centres. In this way persons become expert penmen, singers, and skilful in every employment.

88. *All voluntary exercise should interest the mind as well as strengthen the muscles.* Daily work in the garden, provided the person does all kinds of work, is a good form

of exercise. No kind of exercise is so well calculated to develop all parts of the body in the female and to promote good health as *house-work.*

89. *Walking*, in order to be of benefit, must be active enough to excite perspiration in cool weather. *Running* is a most excellent exercise. In quick walking, running, and rowing with the slide-seat most of the work is done by the muscles of the limbs: hence these exercises should be supplemented by Indian-club, dumb-bell, rope, and ladder exercises, and active vocalization (*a*).

90. *Sports* are to be highly commended. Base-ball, foot-ball, cricket, swimming, skating, gunning, and the riding of a restive horse are most excellent. *Lawn-tennis* is one of the best of modern games, especially for girls. It calls the eye and the mental and motor nerve-cells into interested action, and makes demands on most of the muscles of the body.

INJURIOUS AGENTS.

91. **Alcohol and Work.**—*The best trainers of athletes forbid the use of beer, cider, wine, or spirits.* Common experience shows that men engaged in very hard work, as iron-puddlers, glass-blowers, prize-fighters under training, etc., do their work more easily without alcohol. The habitual use of alcoholics diminishes the deftness of the trained artisan and increases the number of annual sick days.

92. *Alcohol and exposure to cold.* The Russian army on a march in cold weather has no spirit ration. Dr. Hayes,

the Arctic explorer, wrote, "In Arctic countries alcohol is, in almost any shape, not only completely useless, but positively injurious." In the British Antarctic Expedition coffee was found superior to spirits.

93. *Alcohol and exposure to heat.* Experience in India has proved that the teetotallers bear the fatigues and exposures incident to campaigns in hot, moist, malarious countries better than those who habitually use alcoholics. In the opinion of many British officers who lately served in Egypt and the Sudan, the use of alcohol lessened the power to endure severe exertion under excessive heat.

94. *Tobacco should not be used by the young and the growing.* Tobacco slows the body-growth. It prevents the muscles from working properly (71). It weakens the whole system in the young.

95. *Tobacco and adults.* It is probably true that it has enabled some soldiers and sailors to endure hunger, privations, cold, and hardships better than they could have done without it. It, however, has not been shown that it increases the physical powers of those not habituated to its use.

Illustration.—According to Lieutenant Greely, of the nineteen who perished in the Arctic Expedition (1882–84) all were smokers but one, and he was the last to perish. The seven survivors were non-smoking men.

96. *Coffee and tea.* Experience in the Hudson's Bay regions and in the hot districts of China and Australia has shown that for *adults* hot tea is a superior drink for

laborers exposed to heat or to cold. The reports of the French army in Algeria, of the English in India, and of Americans in the Southwest commend coffee as a beverage for men exposed to heat, wet, and malaria.

(*a*) **Training** is accomplished by a course of graduated exercises, by restricting the carbo-hydrates and increasing the fats and proteids of the diet, by the judicious use of water, and by abstaining from dissipation and the use of excitants and sedatives. No one should enter upon a course of training until he has been examined and passed by a competent gymnast-physician. The great dangers in athletics lie in over-training, or in shirking training yet attempting to do the expected work. When these extremes are avoided, the human system is benefited. As a whole, training and athletic competitions probably ward off more diseases than they produce.

GENERAL REVIEW QUESTIONS.

Anatomy of Muscles.

Why are muscles needed? (**55.**) Describe muscle; tendon. (**56, 57.**) How are muscles arranged? (**59, 60.**) What is fat? When does it diminish? (**61.**) How does alcohol affect muscle-structure? (**62.**)

Physiology of Muscles.

Speak of the duty of muscles. (**64.**) What is contractility? What does it do? (**65, 66.**) What movements are executed by the voluntary muscles? (**67.**) Mention the duties of the involuntary muscles. (**68.**) What conditions are essential for muscle-work? (**69.**) How does alcohol influence muscle-action? (**70.**) What is the influence of tobacco on muscle-action? (**71.**) How may opium hinder body-action? (**72.**)

Hygiene of Muscles.

What benefits from regular exercise? (**73, 74.**) What are essential in muscular development? (**75–79.**) What is the effect of exercise on muscle? (**80.**) Why is an erect posture the easiest and best? (**81, 82.**) How should exercises be conducted? (**83, 84.**) What is the advantage of rest? (**85.**) Mention some useful

hints. (86.) What is the value of repetition? (87.) Mention suitable and advisable forms of exercise. (88–90.) What effect has alcohol on muscle-workers? (91.) What results from using alcoholics in cold regions? in hot regions? (92, 93.) Why should muscle-workers not use tobacco? (94, 95.) When may adults safely use tea or coffee? (96.)

BLACKBOARD ANALYTIC SUMMARY OF THE MUSCULAR SYSTEM.

(Chapters VI–IX.)

- **Anatomy of**
  - Fibres
    - Striated.
    - Non-striated.
  - Connective tissue.
  - Fascia.
  - Tendons.
- **Physiology of**
  - Contractility.
  - Voluntary movements.
  - Involuntary movements.
- **Hygiene of**
  - Ample supply of oxygen and foods.
  - Ready removal of muscle-wastes.
  - Systematic regulated exercises.
  - Interesting movements.
  - Frequent rests.
- **Avoidable Causes of Ill Health**
  - Alcoholic fatty change.
  - Alcoholic irregular-movement influence.
  - Tobacco irregular-action influence.
  - Opium paralyzing action.

CHAPTER X.

THE SKIN.

97. The Skin is a membranous covering enveloping the outer parts of the body. It is composed of two layers,—the *ep-i-der'mis* and *der'mis*. (Figs. 16 and 54.)

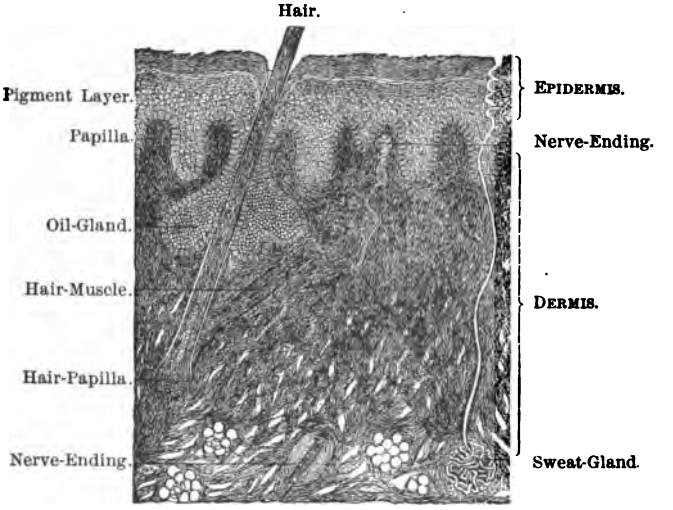

FIG. 16. DIAGRAMMATIC VERTICAL SECTION OF NORMAL SKIN.

In youth, and *in females* particularly, it is smooth, soft, and elastic. *In middle age*, and in males, it is firm and rough to the touch. *In old age*, in persons who are emaciated, and about the flexures of the joints, it is thrown into folds.

98. The Epidermis, or that part of the skin which is seen by the eye, is firm and flexible. It has no blood-vessels, and only a few nerve-endings. (Fig. 16.)

Illustrations.—When dry, this layer scales off (scurf). It is this part of the skin which is raised by a *blister.* Sometimes from disease, as scarlet fever, it comes off from the surface of the body in pieces of considerable size.

99. *The arrangement of the epidermis in different parts of the human body is worthy of notice.* Where feeling is most acute, the epidermis is delicate and thin. Where there is motion, as over the joints, it is lax and movable. Where it is in constant use, it becomes harder and thicker.

Illustration.—The soles of the feet and the palms of the hands afford good examples of the epidermis thickened by use.

100. The Pigment-Layer is the under part of the epidermis. (Fig. 16.) This colored layer, in the Negro, is black; in the Indian, copper-colored; in the European it is very light, differing, however, in different persons.

101. The Dermis is the most essential part of the skin. It contains several sets of tubes,—namely, *cap'il-la-ries* and *lym-phat'ics.* In it also are found *oil-glands*, *sweat-glands*, *hair-papillæ*, and *nerve-endings.* (Fig. 16.) The skin is nourished by the blood.

Observation.—When this layer of the skin is destroyed by cuts or burns, it is never formed again. Scars, which do not disappear, result.

102. The Nerve-Endings and Loops, like the blood-

vessels, are very numerous, for no deep part of the skin can be pricked or cut without giving pain and giving forth blood.

103. The Lymphatics (lim-fat'iks) are those minute tubes which open upon the inner layers of the epidermis (237). These vessels are called into action when ointments are rubbed on the skin, and also in vaccination (274).

104. The Perspiratory Apparatus consists of minute tubes, which pass inward through the epidermis, and terminate in the deeper meshes of the dermis. (Fig. 16.) In their course, each little tube forms a beautiful spiral coil; and, on arriving at its destination, coils upon itself in such a way as to constitute an ovoidal or globular ball, called the *sweat-gland.* (Figs. 16 and 54.)

105. The Oil-Glands are found in the dermis, usually near the hairs. (Fig. 16.) They are most abundant in the scalp and face, and about the nose, mouth, and external ear.

106. The Hair-Papillæ are seated in depressions of the dermis. Upon the hair-papilla (Fig. 16) grows the long oval or cylindrical hair. Hairs are found on most parts of the skin, as is evident in the hairy men (*Ainos*) of Japan.

107. *The use of alcohol occasions in many a change in the structure of the skin.* The skin often becomes reddened, blotched, roughened, and thickened. In some persons it induces dangerous and destructive disease of the skin.

CHAPTER XI.

PHYSIOLOGY OF THE SKIN.

108. *The skin invests the whole of the external surface of the body*, following all its prominences and curves, and gives protection to all the organs it encloses, while each of its several parts has a distinct use.

109. *The epidermis is insensible, and serves as a sheath of protection to the dermis*, which contains the nerves of touch. It also prevents disease, by impeding the evaporation of the fluids of the true skin and the escape of heat, and the absorption of the poisonous matters which necessarily attend various employments. It, however, affords protection to the system only when unbroken, and then to the greatest degree when covered with a proper amount of oily secretion from the oil-glands.

110. *The nerves of the skin are the organs of the sense of touch and temperature.* Through them we receive many impressions that increase our pleasures, many which warn us of dangers.

111. *A considerable proportion of the wastes of the body pass through the outlets of the skin*, some portions in the form of oil, others in the form of watery vapor, of carbonic acid, and of nitrogen wastes.

112. *An oily fluid is separated from the blood by means of the oil-glands.* This secretion is spread over those parts

of the skin most exposed to the changes of temperature and moisture. The oil keeps the skin soft and pliable, and also protects the epidermis.

113. *The sweat-glands, numbering nearly two and a half millions, separate from the blood the per-spi-ra'tion.* It is a clear fluid, having a varying odor and a saltish taste. In health these glands are in constant action, and the skin is moist. When this moisture cannot be seen it is called *insensible* perspiration. When it can be seen in drops it is called *sensible* perspiration (*a*).

114. *The functions of the perspiration are:* (1) to cool the body by its evaporation; (2) to relieve the blood of an excess of water; and (3) to remove certain wastes from the blood.

115. *If perspiration is suppressed from disorder of the skin or cold,* injurious matter is circulated through the system by the blood, disturbing the action of the lungs, liver, kidneys, and other organs. Many cases of chronic coughs, headache, dyspepsia, and diarrhœa originate in this way.

116. *The hair serves as a protector.* That of the scalp keeps the head warm; that of the eyelids keeps dust out of the eyes; that of the body diminishes friction.

117. *The muscles of the hairs lie in the skin.* (Fig. 16.) When they are excited, as by cold, electricity, or fright, they cause the hair to "stand on end."

118. *The nails protect the sensitive tips of the fingers and toes.* They aid the sense of touch; also aid in grasping small objects.

ACTION OF INJURIOUS AGENTS.

119. *Alcohol causes the glands of the skin to work improperly.* Professor Neumann, of Vienna, readily detects the alcoholic tendency of a patient by a peculiar satiny feel of the skin. In such patients perspiration is too readily excited. It causes local congestions, as is seen in the toper's face.

120. *Opium acts to diminish or to dry up the secretions of the glands of the skin.* The skin of the opium-user becomes harsh and wrinkled. The skin of the baby fed with Soothing Syrup too often has a rough, sickly appearance.

121. *The skin of young cigarette-smokers is often of an unhealthy sallow hue.* This is due to the ill effect of the active parts of the tobacco on the feeding qualities of the blood.

(*a*) **Experiment.**—Put the hand into a cold, dry glass jar, or any glass vessel, and wind around the wrist and mouth of the jar a handkerchief. In a few minutes the inside of the jar will be covered with moisture from the hand.

CHAPTER XII.

HYGIENE OF THE SKIN.

122. Clothing, in itself, does not bestow heat, but is chiefly useful in preventing the escape of heat from the body, and in defending it from the heat of the atmosphere.

123. *Woollen cloth* retains more air in its meshes than any other article except furs, and it absorbs into itself the moisture of the skin twice as rapidly as cotton or linen, not leaving it in drops on the skin. As a rule, merino or woollen should always be worn next to the skin.

124. *The clothing should be of a porous character.* The apparel should be made of material that will permit the air to pass through its meshes. Water-proof clothing and overshoes should only be used during the time of exposure to wet.

125. *The clothing should be not only porous, but fitted loosely.* Every one is practically aware that a loose dress is much warmer than one which fits closely; that a loose glove, boot, or shoe will afford greater warmth than one of smaller dimensions (52).

126. *Moisture renders clothing a good conductor of heat.* Damp and wet clothing conducts the heat more rapidly from the arms and limbs than it can be made in, or brought to, the parts, causing a chill of the parts. A person ought not to sit or rest in damp clothing.

127. *More clothing is necessary when a vital organ is diseased.* When vital organs, as the lungs, heart, etc., are diseased, less heat is generated in the body, and the skin is pale and the extremities cold.

128. *More clothing is required in the evening than during the day.* In the evening we have less vital energy, and, therefore, less heat is generated in the system than in the early part of the day. Hence, when returning from evening assemblies, you should be provided with an extra

garment. Put on your overcoat five or ten minutes before going out into the cold.

129. *An excessive amount of clothing, no less than an insufficient one, is injurious.* The custom of wearing an undue amount on some parts of the body, and leaving exposed the arms and upper part of the chest, cannot be too highly censured; also the custom of wearing thin, fragile, close-fitting shoes.

130. *The clothing should be kept clean.* Our apparel takes up a portion of the perspired fluids, and thus the fibres become covered with the waste matter contained in the perspiration. A neglect of a frequent change of apparel is often a cause of disease.

131. *The clothing in which we sleep, as well as beds and bedclothes, should be aired and sunned every day.* If this is not done, the moist bedding may cause a chill. The Italian method of *not* "making up the bed" until the end of the day is worthy of imitation.

132. *When the clothing has become wet it is best to change it immediately.* If the garments are not changed, the person should exercise moderately, so that sufficient heat may continue to be generated in the system to dry the clothing and skin without a chill.

133. *Changes of dress from thick to thin should always be made in the morning*, for then the vital powers are in full play. Sudden changes in wearing apparel, as well as in food and general habits, are attended with hazard.

134. **Bathing** is necessary, in order that the perspirable matter may pass freely from the "pores" of the skin.

The whole body should be bathed frequently, as perspiration is not confined to the face and hands. Good soap only should be used. "Daily bathing from childbirth to old age should be the rule" (*Bowditch*) (*a*).

135. *Sea-bathing is valuable to persons in ordinary health who are fatigued by business cares and mental overwork.* It is not proper for infants, elderly persons, and those suffering from well-seated disease of the kidneys, liver, heart, or lungs.

136. *No person should bathe when the body is fatigued, either by mental or physical labor, or immediately after a meal.* The best time for bathing, particularly for sick persons, is about two hours after breakfast. Persons in health may bathe early in the morning.

137. Cosmetics *often contain lead, bismuth, mercury, and other dangerous and injurious ingredients.* They clog the sweat-gland pores and injure the texture, softness, and health of the skin.

138. Light exercises a salutary influence upon the skin. Thus, we see that those individuals who labor in low, damp, dark rooms are pale and sickly. The kitchen, the sitting-room, and the sleeping-room, which are the apartments most used, should be the most pleasant and best-lighted rooms in the house.

139. *Alcoholics should be avoided by those who wish to maintain a clear, smooth, pliable skin.* The use of alcoholics in excess is a prominent cause in producing a blotched nose and face. *Opium and tobacco*, as they injure the appearance of the skin, should not be used by the young.

(a) **Temperature.**—Vapor and hot-water baths above 97° F. (36° C.) are stimulant. The warm bath, 97° to 85° F. (36° to 29.5° C.), is soothing. The infant's bath should commence at 106° F. and be gradually reduced. The tepid bath, 75° to 85° F. (24° to 29.5° C.), is useful for cleanliness and to keep the sweat-pores open. The temperate bath, 65° to 75° F. (18° to 24° C.), is well adapted to the healthy. The cold bath, 32° to 65° F. (0° to 18° C.), is a stimulant, a tonic, and, later, a sedative. It is adapted only to the robust who have excellent lungs.

GENERAL REVIEW QUESTIONS.

Anatomy of the Skin.

Describe the appearance and structure of the skin. (97.) How does the epidermis appear? (98, 99.) Speak of the hue of the skin. (100.) What structures are found in the dermis? (101.) Describe the perspiratory apparatus. (104.) State facts about the hair and oil-glands. (105.) How does alcohol injure the skin's structure? (107.)

Physiology of the Skin.

Mention the functions of the epidermis. (109.) Mention the secretions appearing on the skin and give their uses. (111, 112.) How does perspiration appear? What is its use? (113, 114.) What is the duty of the hair and hair-muscle? (116, 117.) Mention a peculiar alcoholic effect. (119.) How do opium and tobacco affect the skin? (120, 121.)

Hygiene of the Skin.

What is the use of clothing? (122.) Why is wool an excellent clothing material? (123.) What precautions should be taken? (124, 125.) Why is damp clothing injurious? (126.) When should extra clothing be used? (127–129.) How should clothing be cared for? (130–132.) Mention some hazardous customs. (133.) Speak of bathing. (134, 135.) What precautions should be observed? (136.) How do cosmetics act? (137.) What is the influence of light? (138.) What objection to the use of alcoholics? opium? tobacco? (139.)

BLACKBOARD ANALYTIC SUMMARY OF THE SKIN.

(Chapters X.–XII.)

- **Anatomy of . . .**
  - *Epidermis* . .
    - Blister.
    - Scurf.
  - *Pigment.*
  - *Dermis.*
  - *Appendages* .
    - Hair-Papillæ.
    - Hair Erector Muscles.
    - Oil-Glands.
    - Sweat-Glands.
    - Nails.
- **Physiology of . .**
  - Investing Coat.
  - Protections .
    - Hair.
    - Oil.
    - Epidermis.
  - Sense of Touch.
  - Temperature-Regulation
    - Direct loss.
    - Evaporation of the perspiration.
- **Hygiene of . . .**
  - Clothing . .
    - Woollen.
    - Cotton.
    - Water-proof.
    - Foot-wear.
  - Sun-light.
  - Bathing . . .
    - Cleanliness.
    - Stimulation.
- **Avoidable Causes of Ill Health.**
  - Alcoholic structural changes.
  - Alcholic perspiratory over-action.
  - Use of cosmetics.
  - Dampness of clothing.
  - Improper distribution of clothing.

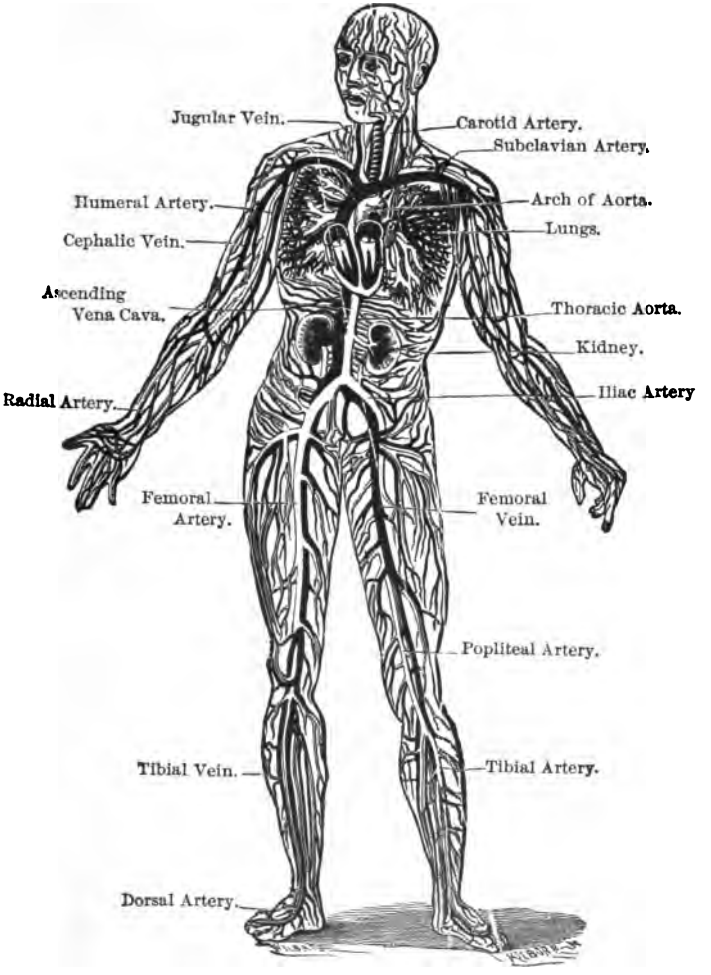

FIG. 17. DIAGRAM OF THE BLOOD-TUBES.—The black lines represent *veins*; the white bands, *arteries*.

CHAPTER XIII.

THE BLOOD AND CIRCULATORY APPARATUS.

THE BLOOD.

140. The Blood is the red fluid of the body (*a*). It is made up of a fluid, the *plas'ma*, and many round disks, red and white, called *cor'pus-cles.* (Fig. 20.)

141. The Plasma is a pale, straw-colored liquid, floating the corpuscles. Dust-like masses of matter may often be seen in the plasma.

142. The Red Corpuscles are about $\frac{1}{3300}$ of an inch in diameter. The *white* are a little larger. The former contain most of the *iron* found in the body.

143. Clotting.—The blood in the healthy living body is always fluid. If it escapes from the blood-tubes, it forms a semi-solid mass, called the clot (474).

Observation.—When a small blood-tube is cut, the blood clots about and within the cut tube, and the bleeding soon ceases.

ANATOMY OF THE CIRCULATORY ORGANS.

144. The Blood is distributed to every part of the system (*b*). There is no part so minute that it does not receive this circulating fluid. This distribution is effected by the agency of the *Heart*, *Ar'te-ries*, *Veins*, and *Cap'il-la-ries.*

145. The Heart is situated in the chest, between the

lungs. (Fig. 30.) It is a double organ, or has two sides, called *right* and *left*, which are separated by a muscular partition (*c*).

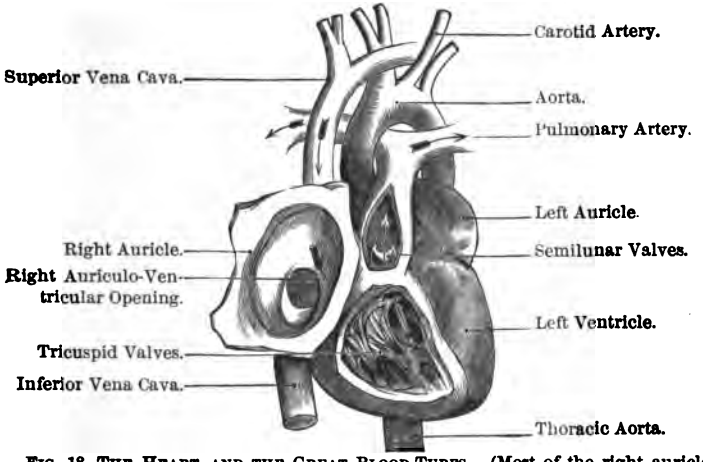

FIG. 18. THE HEART AND THE GREAT BLOOD-TUBES (Most of the right auricle and the front of the right ventricle are cut away, showing their interiors and the pulmonary artery laid open to show the valves.)

146. *Each side of the heart has two cavities.* The upper cavity is called the *au'ri-cle.* The lower cavity is called the *ven'tri-cle.* These cavities are separated from each other by folds of membrane called *valves.* (Fig. 18.)

147. **The Valves.**—Between the auricle and ventricle of the right side of the heart there are the *tri-cus'pid valves.* (Fig. 18.) Between the auricle and ventricle of the left side of the heart there are the *mi'tral valves.* (Fig. 24.) At the entrance of the artery leading to the lungs and the aorta there are the *sem-i-lu'nar* valves. (Fig. 18.)

148. The Arteries are the tubes that carry the blood from the heart. The right ventricle of the heart gives rise to the *pul'mo-na-ry* artery (Fig. 17, [6]), the left ventricle to a large artery called the *a-or'ta.* (Fig. 17, [5].)

149. The Pulmonary Artery (Fig. 38, [r]) conveys the dark-colored or "venous" blood to the lungs, and, with its corresponding veins, establishes the *pulmonic circulation.*

150. The Aorta, conveying the pure or "arterial" blood, gives off branches, which divide and subdivide as they advance until they are distributed to every part of the body. This artery, with its corresponding veins, establishes the *systemic circulation.* (Fig. 17, *the bands in white.*)

151. The Veins (Fig. 17, *the black lines*) are the tubes which return the blood to the auricles of the heart after it has been circulated by the arteries through the lungs and other parts of the body. Certain veins are furnished with valves, which allow the blood to flow toward the heart only. (Fig. 19.) In general, veins are nearer the surface of the body than the arteries (*d*). They accompany all large arteries.

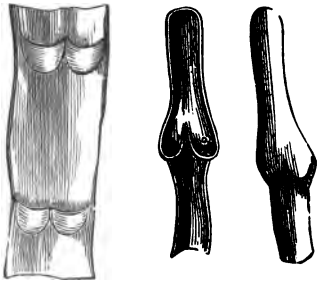

FIG. 19. DIAGRAMS EXHIBITING THE ARRANGEMENT OF THE VALVES OF VEINS.

152. The Capillaries constitute a microscopic net-work, and are so distributed through every part of the body as

to render it impossible to introduce the smallest needle beneath the skin without wounding several of these fine vessels. They establish the communication between the termination of the arteries and the beginning of the veins. (Fig. 24, *c, g, q, m.*)

ACTION OF ALCOHOL.

153. *The continuous use of alcoholics often leads to a change of some of the muscular fibres of the heart and the arteries* (the middle coat of the arteries contains muscular fibres) *to inert fat.* The fatty change often continues to a *chalky degeneration-stage.*

154. *An alcoholic fatty-heart is a weak heart.* It cannot do its work efficiently. It often enlarges. It may suffer rupture, giving rise to sudden death.

155. *A fatty or chalky condition of the arteries renders the blood-tube inelastic and not able to contract, as well as brittle.* Hence, if the heart suddenly beats rapidly and strongly, an artery may crack. This gives rise to *an'eu-rism*, and, in the brain-arteries, to *ap'o-plex-y.*

(*a*) **FOR THE TEACHER. Demonstration of the Blood under the Microscope.**—Prick your finger. As soon as possible, transfer a drop to a clean slide. Breathe on the lower side of the cover-glass, and cover at once. Spread the drop so thin that little color is visible. At first use a 1-inch objective; then a ¼-inch. Study the *red corpuscles.* (1) They tend to take the shape of rouleaux. (2) Focus down; they appear clear on the outside and dim in the centre, then clear in the centre and dim outside,—*i.e.*, they are biconcave. (3) In profile they are dumb-bell shape. (4) Near the edge of the glass they appear crenate, owing to evaporation. Their size is about $\frac{1}{3500}$ of an inch. Find a *white corpuscle.* It is colorless and granular. (Fig. 20.)

FIG. 20. HUMAN BLOOD-CORPUSCLES.

(*b*) **Dissection of the Thorax.**—Place a rabbit, dog, or rat on its back. Make an incision in the middle line of the body, commencing at the lower jawbone. Dissect up the skin as far back as possible on each side, and pin or tie it back with threads. The *ribbed* part exposed is the *thorax*, and the soft part the *abdomen*.

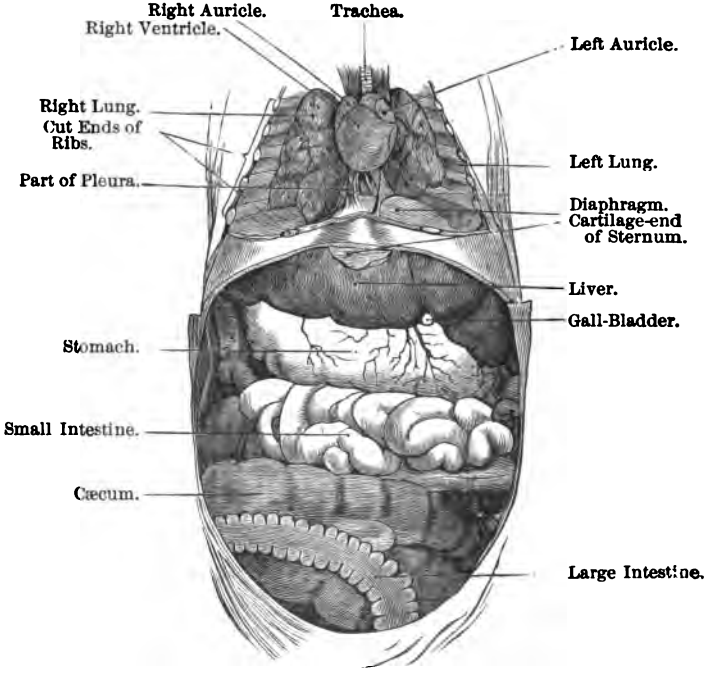

FIG. 21. THE THORACIC AND ABDOMINAL VISCERA OF A RABBIT, AS EXPOSED BY THE REMOVAL OF THE WALLS.

The ribs are seen to be connected with the *sternum* by means of a white, gristle-like material, the *costal cartilages*. Cut through, on each side of the sternum, the white cartilages, making the cut as near the blue, hard rib as possible. At the inferior end of the sternum raise the bone and cut away the muscle, the *diaphragm*, which holds it in place. The freed end is now to be raised, freed from its underparts with a few nicks of the knife, turned over towards the chin, and the ligamentous attachments of the sternum to the right and left upper ribs severed.

Dissect the skin and subcutaneous tissues from the neck parts. On the front

neck, to the right and left, we see a thin tube holding dark blood, the *jugular vein*. Remove the layers of tissue until you expose the white, ring-like tube, the *trachea*, and the cartilaginous enlargement above, the *larynx*. Just above the larynx can be felt a V-shaped bone (*hyoid*). By drawing the muscles and connective tissue from the trachea, there will be brought into view, running nearly parallel to it, a firm, whipcord-like tube, the *carotid artery*; near it, thinner tubes, containing dark fluid, the *veins*, and a white, string-like fibre, the *pneumogastric nerve*. If the larynx is followed upward, it is found to end in a musculo-membranous cavity, the *pharynx*. Beneath and to one side of the trachea is to be seen a collapsed tube with thick fibrous walls, the *œsophagus*, which is seen to be open into the pharynx above.

Observe the contents of the *thorax*,—two lateral compartments, formed by the thin, smooth-surface *pleura*, lining the chest-walls, each compartment containing a shrunken, pinkish-white, spongy organ, the *lungs*, of which the right is the larger. Tie a tube in the trachea, and fill the lungs with air, by blowing into the tube. Notice the deep lines dividing the lungs into *lobes*, and the irregular lines marking *lobules*, situated just under the pleura. Between the lungs is a sac, the *pericardium*, containing fluid and a firm, pear-like, fleshy organ. Projecting and arching into the thorax from the abdomen is seen a muscular and fascia-like partition, the *diaphragm*. The pericardium is attached to this, and should be cut free; but the lungs are not attached to the diaphragm.

Open the pericardium with the scissors. It is seen to contain a small amount of *fluid*, and to be lined by a smooth, close, serous membrane. Floating in this pericardial fluid is a firm, pear-shaped, muscular organ, the *heart*. Its apex, or free point, is turned towards the ribs, and its broad, tube-attached base towards the back.

Note that the *trachea* is seen to divide into two tubes, the *bronchi*, which in turn divide and subdivide as they enter the spongy *lungs*. From the heart are seen tubes, *arteries* and *veins*, running into the lungs in company with the bronchia. Rising from the base of the heart is seen a large, round tube, the *aorta*, which arches, gives off many branches (among them the *carotids*), and passes downwards along the backbone of the animal, giving off branches, and penetrating the diaphragm.

(*c*) **Dissection of the Heart.**—Procure the heart of a sheep, ox, or dog. The front of the heart may be recognized by a groove filled with fat. Hold the heart with the front towards you. The *right ventricle* in your left hand is more yielding, because its walls are thinner than the *left ventricle* in your right hand. Observe the gaping *pulmonary artery* rising near the middle line, and back of it the large, elastic, tubular *aorta*. Tie a tube in the pulmonary aorta and fill it with water. The fluid does not enter the heart, it being stopped by the *semilunar valves*. Test the aorta in the same manner. If the valves are uninjured the water will not pass into the heart.

Observe the size, form, and thickness of the walls of the *auricle* and its dog-ear appendage. Cut away most of the *right auricle*. Holding the ventricles in the left hand, pour some water suddenly through the opening into the ventricle. The *tricuspid valves* will float up and close the opening. Allow the water to pass out through the semilunar valves. Introduce the scissors between two of the folds of the tricuspid valve, and cut a slit through the ventricular wall to the apex; then

turn the scissors and cut alongside of the septum towards the pulmonary artery. Observe on the ventricular side of the tricuspid valves the many thin fibres attached to the folds of the valves, the *chordæ tendineæ* and their attachment at the other end to the *columnæ carneæ*, or muscular pillars.

Hold the heart vertical. Pour water into the *pulmonary artery*. Raise the ventricular flap, and observe from below the form and mode of closing of the *semilunar valves*. Then continue the last incision, and lay open the semilunar valve and the pulmonary artery. Notice the little nodules in the free edge of each flap, the *corpora Arantii* and the little pouches in the arterial walls opposite each flap, the *sinuses of Valsalva*.

Lay open the *left auricle* in the same manner as the right. Study the mitral valve, and use water as before. Note the thickness of the walls of the *pulmonary veins* and of the *auricles*. Lay open the *left ventricle* in the same manner as the right. Note the very thick walls and the great firmness of the tissues near the apex. Compare the walls of the auricles and ventricles as to thickness and firmness. Observe the *mitral valve* from the ventricle. Notice its greater thickness and rigidity as compared with the tricuspid, also the increased size and strength of the chordæ tendineæ and the columnæ carneæ. Lay open the aorta. Examine its coats, their layers, thickness, and elasticity. Study the semilunar valve, the corpora Arantii, and the sinuses of Valsalva. Observe the entrance to the *coronary arteries* (the nutrient arteries of the heart-muscle) in the anterior sinuses.

(*d*) **Experiment.**—Tie a string around the forearm below the elbow, but not so tightly as to stop the radial pulse. The veins at the back of the hand soon become distended. Little venous prominences, about an inch apart, may be seen. These indicate very nearly the position of the valves. On one vein press on the finger side of the valve, then stroke the blood to beyond the next valve, and the intermediate portion of the vein will lose its distention,—that is, the valve prevents the reflux of the blood. Remove the finger-pressure, and the tube again appears, owing to the fact that the heart is constantly pumping blood into the veins. At this time apply the finger at the wrist, and the pulsation of the arteries still continues, showing that the blood is constantly flowing from the heart through the arteries into the veins; and the increased size of the veins shows that the pressure of the string prevents its flowing back to the heart.

CHAPTER XIV.

PHYSIOLOGY OF THE CIRCULATORY APPARATUS.

156. **The Blood** is the vital fluid of the body. All the tissues live on this complex fluid.

157. The *plasma* penetrates to every nook and corner of the body (*a*). It is the tissue-food. It floats the corpuscles and the tissue-wastes.

158. The *function of the red corpuscles* is to bear oxygen (received in the lungs and skin) to every part of the body. The *white corpuscles* show amœba-like changes of form, but their function has not been definitely made out.

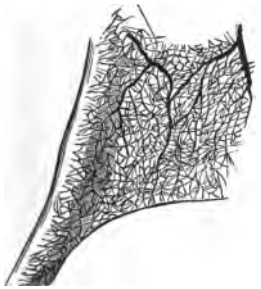

FIG. 22 (*Wagner*). A PIECE OF THE WEB OF A FROG'S FOOT, showing the fine capillary net-work connecting the termination of the arteries with the commencement of the veins.

FIG. 23 (*Allen Thomson*). MINUTE PIECE OF THE MARGIN OF THE FROG'S WEB, showing the ultimate capillaries and the oval blood-corpuscles. The arrows indicate the course.

159. *The walls of all the cavities of the heart are composed largely of muscular fibres.* The contraction and relaxation of the muscular fibres of the heart increase and diminish

the size of its cavities. During the relaxations the heart-muscle rests. In one day the rests amount to over eight hours.

160. The *two auricles dilate* at the same instant, and also contract at the same instant. The *two ventricles contract* while the auricles dilate. By these contractions the blood is forced from the heart to every part of the body.

161. *Every time the heart contracts there is a "pulse," or pulsation, in the arteries* (*b*). The frequency of the pulse varies according to the age, sex, and degree of health. In adults it is usually about seventy "beats" a minute. In health there is no "pulse" in the veins.

THE COURSE OF THE CIRCULATION.

162. **Pulmonic Circulation.** (Fig. 42.)—From the right ventricle the dark, impure blood is forced into the pulmonic artery, and thence into the capillaries of the lungs. In these capillaries a part of the carbonic acid of the venous blood is cast out and oxygen is taken in, changing the red corpuscles to a bright red. The blood now courses through the pulmonic veins to the left auricle. When the mitral valves open, the bright blood enters the left ventricle.

163. **Aortic (Systemic) Circulation.** (Fig. 24.)—By a forcible contraction of the left ventricle the blood passes the aortic semilunar valves and enters the aorta (*a*). Its branches convey the blood to all parts of the body. In the systemic capillaries the blood loses foods and oxygen,

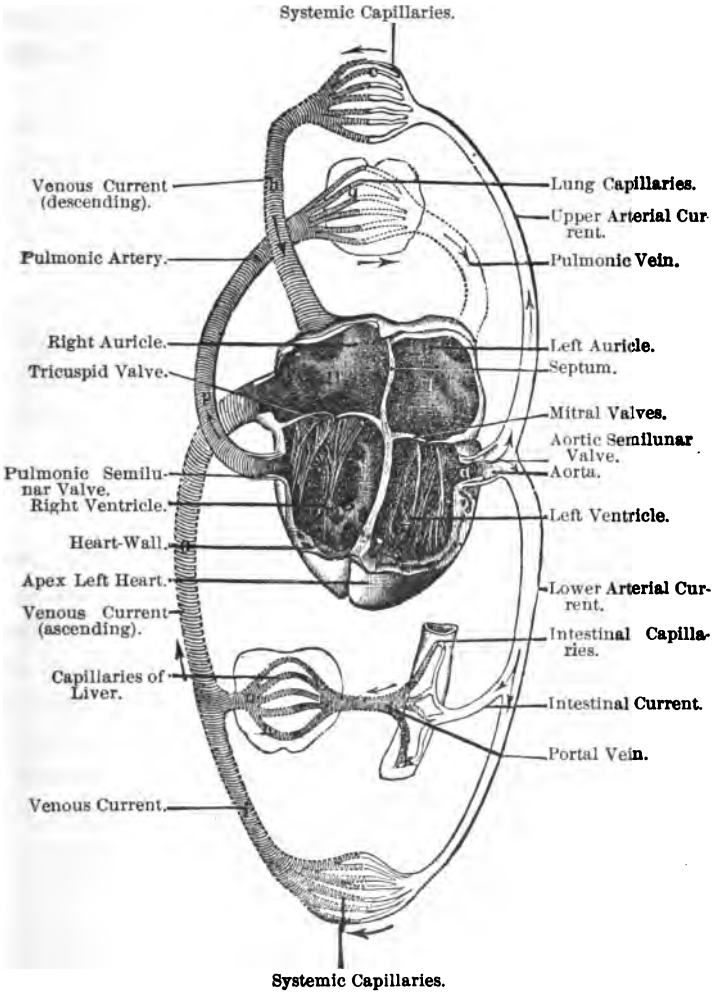

FIG. 24. SCHEMA OF THE CIRCULATION (*Letourneau*).—The arrows indicate the direction of the blood-current.

takes up wastes, and becomes dark-colored,—that *is*, *venous*. In the intestinal capillaries it receives new foods. In those of the liver it undergoes a change. The venous blood is conducted to the right auricle by the venous vessels. When the tricuspid valves open, the blood enters the right ventricle.

164. Action of the Valves. (Fig. 24.)—The *tricuspid valves* prevent the reflow of the blood from the right ventricle to the right auricle. The *semilunar valves* prevent the blood passing from the pulmonic artery to the right ventricle. The *mitral valves* prevent the flow of blood from the left ventricle to the left auricle. The aortic *semilunar valves* prevent the reflow of blood from the aorta to the left ventricle.

ACTION OF INJURIOUS AGENTS.

165. Moderate Doses of Alcohol *overcome the heart-control*,—hence the heart beats too frequently. Alcohol usually causes unnecessary, useless heart-work. It lessens the period of the heart's rests. A *large dose* rapidly slows heart-action (poisoning).

166. *Alcohol constantly in the blood injures the plasma and the corpuscles.* It is said to change the form, to lessen the size, and to diminish the number of the red corpuscles. Also it may render the corpuscles adhesive, preventing free movements.

167. Tea, *as commonly taken, is a spur to the weary heart.* It causes the heart unnecessary extra work at the time it desires less work. When used in excess it causes an un-

pleasant change in the heart's action, known as the "tea-drinker's heart."

Illustration.—The excessive consumption of tea among the women of the poorer classes (and of the teacher class, too) is the cause of much of the so-called "heart-complaints" among them. (*Yeo.*)

168. **Tobacco,** *in many persons, causes the heart to beat too fast, in others too slow, and in others irregularly.* It always acts badly on the young and the growing.

169. *In "tobacco-heart" the heart beats irregularly.* The sick person suffers from occasional pains, occasional sudden bad actions of the heart. These are all due to the evil action of the tobacco taken on the brain-cells, the blood, the heart-muscle, and heart-nerves.

Observation.—The cessation of the use of tobacco is, as a rule, followed by the complete cure of "tobacco-heart."

170. **Chloral** (*klo'ral*) *is a dangerous drug.* When taken for some time without apparent effect its energy may suddenly burst forth, causing the heart to beat irregularly and feebly, and even arresting its beats. Hence chloral should be used only as the doctor from time to time directs.

(a) **FOR THE TEACHER. Demonstration of the Blood Circulation.**—Wrap a live frog in a cloth, allowing one hind limb to project out. With tapes fasten him on a piece of stiff card-board. Near the toes of one outstretched hind limb cut a hole in the card three-quarters of an inch in diameter. Attach threads to two adjacent toes. So arrange the threads that the stretched web comes over the centre of the hole. Place a drop of water on the web, and over the same a thin cover-glass. Use on the microscope a 1-inch or ¾-inch objective. Observe the moving bodies; the *red* and the *white* corpuscles; the comparatively small number of the latter; the walls of the channels; the rapid central current; the slow wall-current; and the pigmented granules in the web.

(b) **Demonstration of Action of the Heart and of the Pulse.**—Place the hand on the bare chest of a boy, over the fifth and sixth ribs, about two inches to the left of the sternum. A slight concussion, the *impulse* of the heart, is felt. This coincides with the *systole* (contraction) of the ventricles. Put two fingers on the wrist-pulse of the boy (the artery-beat may be felt on the thumb side of the wrist over the lower end of the radial bone, palmar side) and place the ear on the impulse-area: a deep, dull, long sound is heard at the time of the impulse and just before the pulse at the wrist. This is the *first* sound, and coincides with the ventricular systole and the closure of the mitral and tricuspid valves. Then place the ear to the left of the sternum over the space between the second and third ribs; a sharp, high-toned, ringing, short sound is heard directly after the duller first sound. This is the *second* sound, and coincides with the closing of the semilunar valves.

With colored chalk or ink mark on the skin the course of the main arteries of the neck, arms, and legs. Call special attention to the places over which the "field tourniquet" may be applied to control bleeding. (Fig. 65.)

CHAPTER XV.

HYGIENE OF THE CIRCULATORY APPARATUS.

171. *The clothing should be loosely worn.* No article of apparel should be worn so as to prevent a free flow of blood through every organ of the body. Elastic bands only should be used.

Observations.—(1) Inelastic bands worn upon the lower extremities are a frequent cause of enlarged veins and painful limbs. (2) Public speakers and brain-workers (students and teachers) ought not to wear stiff, close-fitting neck-wear.

172. *Woollen (or cotton and wool "patent merino") underclothing should be worn night and day by those in feeble health.* Such clothing tends to equalize the work of the heart, and thus favor the heart.

173. *Muscular exercise is important in maintaining a healthy circulation.* The muscles, when used, force the blood more rapidly to and from the heart.

Illustration.—The coach-driver and teamster throw their arms around their bodies to warm them when cold, because the muscles that are called into action in swinging the arms force a greater quantity of hot blood into the chilled parts; also heat-production is increased.

174. *Fainting is commonly due to sending impure blood to the heart.* It is accompanied by a slowing or even stoppage of the heart's action. Not only may bad air cause it, but "tight-lacing," great bleeding, pain, and even fright.

175. *A broad flannel waist-band should, during the summer and autumn, be worn at night next to the skin of the abdomen.* This will keep the circulation in the abdomen more equable and will largely prevent griping, colics, and sudden morning diarrhœas (di-ar-re'as).

176. *Fatty-heart* more often follows the steady use of malt liquors than of wine and spirits. *Tobacco-heart* is proportionately more common in youthful smokers than in adult smokers.

177. *The physiology of the heart and blood-tubes* testifies against the use of alcohol and tobacco (153, 165) by adults as well as the young. No young person should be allowed to use alcohol, chloral, tea, or tobacco.

178. *In cases of sudden, severe injury, fainting, or wounds,* administer hot water and ammonia, hot coffee, or hot tea, rather than alcohol in any form. *Alcohol in large doses is*

a heart-sedative (165). Hence, in snake-bite, do not flood the patient with whiskey.

GENERAL REVIEW QUESTIONS.

Anatomy of the Circulatory Organs.

Describe the blood. (140–142.) Describe clot-formation and its use. (143.) How is the blood distributed? (144.) State the anatomy of the heart. (145–147.) Give the pulmonary artery distribution. (149.) Describe the systemic circulation. (150.) How do veins differ from arteries? (148, 151.) Where are capillaries found? (152.)

What heart-structure changes are induced by alcohol? (153, 154.) How does alcohol change the structure of arteries? (155.)

Physiology of the Circulatory Organs.

Mention the functions of the blood. (156–158.) Describe the heart's work. (159, 160.) How is the pulse caused? (161.) Give the course of the circulation. (162, 163.) What is the duty of the valves? (164.)

How does alcohol modify the heart's action? (165.) What is the action of alcohol on the blood? (166.) What is the influence of tea on heart-action? (167.) What peculiar actions or feelings in "tobacco-heart"? (168, 169.) Why is chloral dangerous? (170.)

Hygiene of the Circulatory Organs.

Why should loose clothing be worn? (125, 171, 172.) How does exercise influence circulation? (173.) Mention causes of fainting. (174.) When should a "waist-band" be worn? (128, 175.) What circulation-objections to the use of alcohol or tobacco? (176, 177.) Why should not alcohol be freely used in snake-bite cases? (178.)

BLACKBOARD ANALYTIC SUMMARY OF THE CIRCULATORY APPARATUS.

(Chapters XIII.–XV.)

- **Anatomy of**
  - Heart.
    - Muscle.
    - Auricles.
    - Ventricles.
    - Valves.
  - Arteries.
    - Aortic Branches.
    - Pulmonic Branches.
  - Capillaries.
  - Veins.
    - Systemic.
    - Pulmonic.
- **Nature of the Blood.**
  - Red Corpuscles.
  - White Corpuscles.
  - Plasma.
- **Physiology of.**
  - Rhythmic contractions.
  - Blood-motion.
  - Course of circulation.
  - Pulse.
- **Hygiene of.**
  - Absence of constriction.
  - Well-distributed clothing.
  - Woollen undergarments.
  - Regulated exercises.
- **Avoidable Causes of Ill Health.**
  - Alcoholic blood-changes.
  - Alcoholic heart-overwork.
  - Alcoholic heart- and artery-structural changes.
  - "Tobacco-heart" irregularity-actions.
  - "Tea-heart" irregularity-actions.
  - Chloral heart toxic action.

CHAPTER XVI.

FOODS.

NEED OF FOODS.

179. *The living human body is a self-increasing, self-repairing machine.* In many respects it is like a combined boiler and steam-engine, which consumes water and fuel (food), gives forth heat, furnishes motion, has wastes (escaping steam, smoke, and ashes), and suffers wear of its parts.

180. *All the actions of the parts of the body cause wear and the formation of wastes.* The building up of thoughts, the formation of the secretions, the digestion of the food, the contractions of the muscles,—in short, every activity of the living body occasions wear and wastes, and uses up materials.

181. *Foods are taken by the living body:* first, to make good the wear; second, to furnish fuel for the continued action of the living engine; and, third, to provide for the growth of the immature body.

182. *Foods furnish the materials which build up, repair, and sustain the system.* A food is a substance which, when utilized or destroyed in the system, gives forth heat or force. *Examples:* oxygen, table-salt, water, meat, sugar.

CLASSIFICATION OF FOODS.

183. I. **The Proteid Class** includes those foods which contain the chemical element *nitrogen* (ni'tro-jen). The element nitrogen is found in the essential parts of the living body. Hence a good diet must always include materials of this class.

The proteids are mostly derived from the flesh of animals, birds, and fishes; from eggs and milk-cheese; from peas, beans, and vetches; and from wheat, barley, oats, and maize (corn) flours or preparations.

184. II. **The Starch and Sugar Class** contains no nitrogen. Its substances are mostly derived from the vegetable world. They form a most important part of a good, sustaining diet.

This class embraces the *starches* of the grains, roots, and tubers, the *sugars* of the cane, beet, sorghum, fruits, honey, and milk, the *vegetable-acid salts* of fruits and vegetables, the *cellulose* of plants and grains, and the *vegetable extractives.*

185. III. **The Fat and Oil Class** is represented in the diet-lists of most peoples, as in the blubber of the Eskimo, the lard of the American, the olive-oil of the Italian, and the rapeseed-oil of the Japanese. These substances contain no nitrogen. Maize is rich in fats. When digested, fats are about two times more valuable as foods than the same weight of the starch-sugar foods.

186. IV. **The Water and Mineral Class** is as essential for health as the proteid class. Upon the elements of

this class depends the integrity of the living framework (31). A generous diet made up from the food-substances of the first three classes will contain all the mineral matters needed, with perhaps the exception of table-salt.

Observation.—Infants and young children who live in dark, damp, and almost sunless rooms, and who are fed on poor milk (whether mother's or cow's milk), arrow-root, and white-flour compounds, develop soft bones ("*rickets*"). The softening is due to the lack of sufficient mineral elements in the food.

187. V. **The Appetizer Class** includes pepper, mustard, ginger, relishes, acids, flavorings, and bitters. To those in health stimulating appetizers are not necessary. Children should be brought up to live upon unflavored, unspiced foods.

188. *A certain amount of each of the first four classes must be present in a perfect diet.* The best proportion for the common wants of the adult human system is about twenty-two of proteids, sixty-nine of the starch and sugar class, and nine of fats. In such a diet there will be sufficient minerals.

189. *The amount of food required by a healthy man is large.* He demands, under average work, about five and a half pounds of water and one pound and a third of dry food-substances every twenty-four hours. In general, *women* require from one-third to one-fourth less than out-door male laborers. At the *fourteenth year* a healthy child needs as much as a woman; at the *tenth* year about a third less.

KINDS OF FOODS.

190. Milk is the best of foods for the young, the convalescent, and the aged. The proportion of the proteids and fats is relatively large, its digestion is easy and rapid, and its feeding-power is great, because there is little waste.

191. Eggs are a concentrated food. Eggs should not be boiled or fried. They may be well cooked by placing them in hot water, in which they should remain from seven to twelve minutes.

192. Meats contain a large amount of proteids united with much fat. Good meats are easily and rapidly cooked. They are more easily digested than vegetable foods, are largely absorbed, and furnish but little waste. Salt meats, so far as nutriment is concerned, are about as good as fresh meats from which a good soup has been extracted.

193. Parasites.—Fresh pig's flesh may contain the *Trichina* (Fig. 25), or the "cyst-worm" of a tape-worm (*Tænia solium*). Sheep's liver may contain the "fluke-worm" (*Distoma*). *Our safety against all these intruders is to cook flesh thoroughly.* Thorough roasting is safest (*a*).

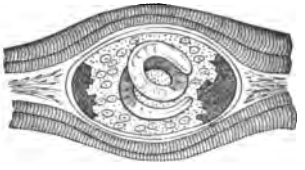

FIG. 25. TRICHINA SPIRALIS (in a lime-capsule within human muscle). —After *Leuckart.*

194. Fish.—Fish, as food, is not equal to flesh. When salmon, herring, shad, or white-fish are "cheap," they are

the most economical of animal foods in proportion to their nutriment. Fish average about the same percentages of proteids as the meats, but in general have less of fats.

195. Wheat contains much nutriment in small bulk. The "fine flour" made from wheat is lacking in flesh-formers, fat-formers, and bone-formers. "New Process flour" makes sweeter, more nutritious, and more wholesome food than does common white flour (*b*).

196. Bread is an article of diet of which few weary. When made from white flour it is deficient in salts, in fats, and in proteids. Bread ought to be from one-fifth to one-third crust. No part should be sodden (*c*).

197. Succulent Vegetables (cabbage, lettuce, parsnip, turnip, etc.) are eaten chiefly for the juices and starches which they contain, and are prized for certain flavors peculiar to each. Their feeding power is small. All vegetables should be sound and well preserved, or fresh.

198. Fruits are most valuable for their acid salts, their flavors, and their sugars. Most fruits are agreeable, refreshing, and cleansing, rather than sustaining. Ripe fruits, in their season, are beneficial and healthy.

COOKING.

199. *The simpler methods of cooking make the most wholesome foods.* Cooking demands knowledge, skill, and attentive waiting.

200. *Roasting and broiling are the best methods of cooking meats.* The heat, at first, should be intense, in order to form a protective film which shall retain the juices.

Later, the heat should be moderate, but long continued. The roasting of fruits and potatoes renders them more palatable, digestible, and nutritious. The baking of flour renders it sweeter, breaks the starch-grains, and makes the starch more digestible.

201. *In boiling meats*, first plunge the flesh into boiling-hot water. Retain it there a few minutes. A protective film is formed. This film helps to retain the nutritive juices. Now cook it in water of a temperature of 160° F. (71° C.) for a very long time.

202. *The cooking of substances in melted oils and fats is a most objectionable method.* The heated fats more or less permeate the food-mass. They also hinder the access of the digestive fluids to the food-materials. A heated fat is very indigestible.

(*a*) On September 15, 1883, a trichinous pig was killed at Emersleben, Saxony. The flesh was disposed of on that and the following day. According to Saxon custom, nearly all the flesh was eaten in a raw state, or in a green smoked state, as minced meat. The earliest illness occurred on September 18; by the 28th the disease was quite prevalent. Up to November 11, out of a population of about 1000 persons, there had occurred 361 cases, of which 57 had proved fatal.

(*b*) ***Maize*** contains a large amount of fats as well as of starch. It requires a longer and a more careful cooking than wheat or oats. It is an excellent food-stuff for robust persons living in a cold climate and engaged in hard out-of-door labor.

The *oat* has not only a large amount of proteids, but it is rich in fats. It is more easily cooked than wheat. When well cooked, its preparations make excellent foods for sustained mental and physical labor. Oatmeal made into a thin gruel is a sustaining and cooling drink for men exposed to great heat, as stokers, puddlers, etc.

Barley contains a larger amount of digestible proteids than wheat. It is very rich in phosphates and iron. The athletes of ancient Greece were trained on a barley diet.

Rice contains the most easily digested and most perfectly assimilated of the starch-grains. It is very poor in proteids, fats, and salts. Rice is four times as nutritious as potato (*König*), and is also more uniform in quality. Rice and millet form the chief food of more than half of the people of the world.

Potato (Irish) has a very low feeding rank. Its starch is very digestible. It is very poor in proteids and deficient in fats. Upwards of 75 per cent. of the best potato is water. When consumed in excessive quantity (the regular allowance of an Irishman at home is ten and one-half pounds daily (*Smith*), potatoes fail to nourish the frame, they make the blood watery, they render the muscles weak, and they form imperfect bones. To save the most of their little nutriment, potatoes ought to be cooked in the skins. The *sweet potato* has a higher nutritive value than the common potato.

Beans and Peas are distinguished from other seeds by containing a very large amount of proteids (legumin). They are rich in starches, sulphur, and phosphorus. In order to be cooked they demand very long boiling and baking. The skins should be rejected on account of their irritant qualities. As these seeds are deficient in fats and contain much nitrogen, digestion is facilitated by combining pork and other fats with them. Even when well cooked, these seeds demand strong digestive powers in order to utilize their stores of energy. In rice and millet countries the people are indebted to beans, peas, vetches, etc., for their highest nourishment.

(*c*) **Alcohol in Yeast Bread.**—"The mean amount of alcohol in fresh bread (yeast) is .813 per cent.,—that is, a pound of bread would yield, if very carefully distilled, about twenty-two grains (considerably less than a teaspoonful). As the bread gets staler the quantity disappears." (*A. W. Blyth, M.D.*, 1883.)

CHAPTER XVII.

BEVERAGES.

203. Water constitutes sixty-eight per cent. of the entire body. A good water has these characters: clearness, freedom from odor or taste, good aeration, coolness, and a certain degree of softness.

204. Fresh, Cool Water (40° to 50° F.; 10° to 15.5° C.) is a tonic to the stomach. Each adult requires upwards of two quarts of water, taken as water, or in tea, coffee, etc., every twenty-four hours (*a*).

205. Living Organisms in Waters are the causes of much disease. The germs of *typhoid fever*, *yellow fever*,

and of *cholera* are most often conveyed from the diseased to the healthy in the drinking- and cooking-water (*b*).

Observation.—Germs may be carried in moist, warm air. A hot, dry air is unfavorable for their vitality.

206. *Shallow-well-waters are dangerous.* (Fig. 26.) In populated places, in old towns and cities, and at home-

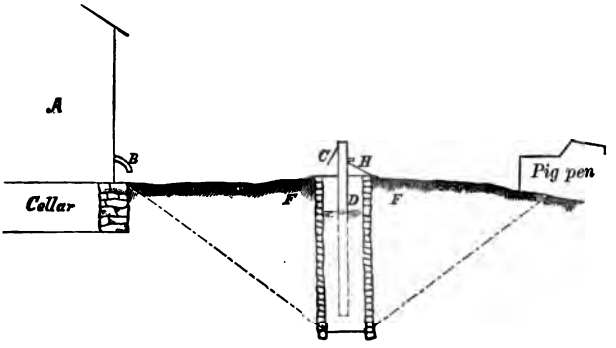

FIG. 26. WELL-DRAINAGE CONE OF A SHALLOW WELL.—*A*, house; *B*, sink-spout; *C*, pump, thirty feet from the house; *D*, well, twenty feet deep; *F*, cone of soil; *H*, sloping pump-trough.

steads where the well is located near the privy and the barn, the water is commonly polluted with human and animal excreta and sink-waste. "Shallow-well-water often consists largely of the leakage and soakage of the receptacles for human excrement." (Fig. 26.)

207. When Cholera or Yellow or Typhoid Fever is prevalent, all drinking-waters, and especially those from suspicious sources, ought to be well boiled and thoroughly agitated or stirred in the open air before being used. The boiled water should be cooled, not by

putting ice into it, but by packing ice about the water-bottle or tank, for ice is often impure.

Observation.—Filtration is not adequate to remove disease-germs. A dash of brandy, whiskey, or wine in the water, or in the stomach, will not destroy germ-vitality.

208. Cow's Milk is best when taken in the fresh state. Milk should not be taken by the glassful at a gulp. It ought to be taken by swallows, with short intervals coming between, otherwise large indigestible curds may form. A tumbler of fresh milk, as hot as it can be sipped, is an excellent morning "pick-me-up."

Observation.—Milk should be procured from healthy cows which are fed on normal food (not city or brewery slops), furnished with pure water, and kept in clean, ventilated stables. The milk from young cows is to be preferred.

ARTIFICIAL DRINKS.

209. Soda Water (seltzer) is water which has had a large amount of carbonic acid gas forced into it. The "syrups" used may be made from the appropriate fruits and seeds or from cheap chemical compounds.

210. Mineral Water is a water which contains a notable quantity of substances which are commonly used as medicines, like iron-compounds, sulphur-compounds, magnesia-compounds, etc.

211. Cocoa is made from the seeds of the *Theobroma*, growing largely in tropical America. *Chocolate* is made from powdered cocoa, with sugar and spices. Cocoa con-

tains some proteids and fats, and is more nutritious than tea or coffee (*c*).

212. **Coffee** is made from the roasted berry of a plant largely cultivated in Brazil, Java, and Costa Rica. The active principle of coffee is a nitrogen-compound called *caf'fe-in* (*c*).

213. **Tea** is made (in America) from the dried and "doctored" leaves of plants largely cultivated in Asia. The Indian, the Chinese, and the Japanese teas are derived from different plants and are differently "fired." The active principle of tea is *caf'fe-in*. The tea-leaf is rich in *tan'nin*.

214. **Alcohol** is a fluid made from sugar dissolved in water by the process of *fer-men-ta'tion*. The sugar may be, and most often is, derived from the starches of grains and roots. The alcohol is separated from the water by the process of *dis-til-la'tion*. Alcohol contains the same chemical elements as sugar or starch.

215. *Beer*, *cider*, *wines*, *and spirits*, when pure and

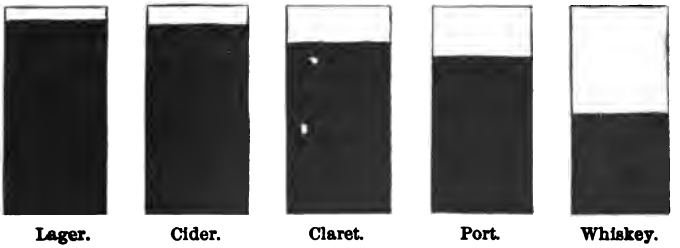

FIG. 26a. The white space shows the proportion of alcohol in each of the measures.

ripened, owe their exciting, their intoxicating, and their

narcotic effects to the *alcohol* which they contain (*d*). Recent spirits contain an active poison called "fusel oil." Some "made wines" and "made spirits" have been known to contain other drugs in dangerous doses.

Chemical Composition of Some Beverages.

	Water.	Alcohol.	Proteids.	Starch-Sugar Class.	Fat Class.
Milk . .	86.	0.	4.	5.	4.5
Ale . . .	86.	7.	0.	5. to 6.	trace.
Beer . .	87. to 95.	2. to 8.	0.5 +	5. +	
Cider . .	88. to 96.	5. to 10.	trace.	2. +	
Claret . .	81. to 90.	9. to 15.	0.	2. +	
Port . .	78.	17.5	0.	3. +	trace.
Brandy .	52.	47.	0.	trace.	trace.
Whiskey .	42. to 49.	40. to 50.	0.	trace.	

216. Fermented Drinks.—The process of making *beer* is called brewing. Barley is sprouted, and then heated to kill the germ. By this germinating process the starch of the grain is changed to sugar. The barley, to which water has been added, is now exposed to the action of yeast (a ferment—a living plant) in the presence of hops. The sugar splits up into *alcohol* (*d*) and *carbonic acid gas*. This latter escapes as bubbles. The resulting fluid (beer) is put into casks and kept for some time in cold, dark vaults, in order to ripen. *Cider* is made from fermented apple-juice, and *wine* from fermented grape-juice.

217. Spirits, or Distilled Drinks.—When a fermented fluid is heated the alcohol is driven off in the form of a vapor. This is condensed in the "worm" of the still, and appears as a stronger alcoholic fluid. This process is called *distillation*.

Rum is distilled from fermented molasses, *brandy* from fermented grape-juice, *whiskey* from sprouted and fermented corn or potatoes, and *gin* from sprouted and fermented grain combined with juniper. Distilled liquors contain from forty to fifty-five per cent. of alcohol.

(a) **FOR THE TEACHER. Comparative Value of Waters.**

Wholesome.	1. Spring-water.	Very palatable.
	2. Deep-well-water.	
	3. Grass-land surface-water.	Moderately palatable.
Suspicious.	4. Stored rain-water.	
	5. Surface-water from cultivated land.	
Dangerous.	6. River-water, with sewage access.	
	7. Shallow-well-water.	

(*Frankland.*)

(*b*) **Typhoid Fever.**—In the United States there are annually upwards of 150,000 cases of typhoid fever, of which more than one-sixth die. Fully one-half of this illness and mortality might be prevented by greater cleanliness and more attention to sewage. "All towns which have been provided with good drainage and water supply have lost their susceptibility to cholera." (*Pettenkofer*, 1886.)

(*c*) **Percentages.**—*Cocoa*, as commonly drank, contains about two per cent. of the active principle; "*medium coffee*," about seven per cent. of the active part; "*strong coffee*," from twelve to fifteen per cent.; "*weak tea*," as little as two per cent. of the active drugs; "*ordinary tea*," from four to five per cent.; and "*strong tea*," as much as seven per cent. (*Yeo.*)

(*d*) **Demonstration of the Properties of Alcohol.**—Examine some alcohol and note: *absence of color*; "*alcoholic*" *odor*; *hot, biting taste*; *volatility* (place a few drops on the back of the hand); *inflammability* (fire a little in a saucer); *complete combustibility* (the flame of the alcohol-lamp has little color and little or no smoke, and affords intense heat); *low boiling-point* (heat a little in a test-tube having a thermometer in the liquid); *uncongealability* (impossible to freeze or reduce to a solid state); *tenuity* (small size of its drops); its *ready mixing with water* in all proportions.

Uses of Alcohol.—About one-half of the alcohol made in the United States is used in the arts and for scientific purposes: in alcohol-lamps by artisans and students; in the preparation of drugs; in the making of perfumery and essences; in the manufacture of "patent medicines," ether, chloroform (the latter may be now made from *acetone*), and varnishes; in the making of rubber goods of all kinds; in museums for the preservation of specimens and in scientific work; as a medicine, etc.

Drug-Demonstration.—Procure a little *powdered opium*; call attention to the color, odor, and taste; state its one good use, to *relieve pain*; show a little *morphia*;

call attention to the color, taste, and the form of crystals of this most active part of opium. It is about eight times as powerful as powdered opium.

Call the attention of the class to the *tobacco-leaf;* the forms into which it is changed for sale,—leaf, plug, cut, snuff, etc.; its odor and taste, and its combustibility; its peculiar smoke.

GENERAL REVIEW QUESTIONS.

Foods.

Why are foods needed? (180–182.) Give a classification of foods, and mention examples under each class. (183–187.) What foods should be supplied? What amounts? (188, 189.) State facts about animal foods. (190–194.) Mention objections to white-flour compounds. (195, 196.) For what are fruits and vegetables valuable? (197, 198.) Compare the different methods of cooking. 199–202.)

Beverages.

Mention the characters of a good water. (203, 204.) How are diseases spread through drinking-water? (205–207.) Speak of milk and its source. (208.) Compare cocoa, coffee, and tea. (211–213.) How are alcoholics made? (214, 215.) Compare fermented and distilled liquors. (216, 217.)

BLACKBOARD ANALYTIC SUMMARY.

(Chapters XVI, XVII.)

- BEVERAGES.
  - *Natural.*
    - Water.
      - Properties of.
      - Amount needed.
      - Dangers in.
      - Precautions.
    - Milk.
    - Mineral Water.
  - *Artificial.*
    - Soda Water.
    - Cocoa.
    - Coffee.
    - Tea.
    - Alcoholics.
      - *Fermented.*
        - Ale, Beer
        - Cider.
        - Wines.
      - *Distilled.*
        - Brandy.
        - Gin.
        - Rum.
        - Whiskey.

- **Foods**
  - *Need of*, *Definition of*, *Classes of*
    - Proteids.
    - Starch and Sugar.
    - Fat and Oil.
    - Water and Mineral.
    - Appetizers.
  - *Amount needed*
    - Adults
    - Women.
    - Youths.
    - Children.
  - *Kinds of*
    - Milk.
    - Eggs,
    - Meats, { Fresh. / Canned, / Salted.
    - Fish,
    - Grain-foods.
    - Vegetables.
    - Fruits.
  - *Preparation of*
    - Roasting or Broiling.
    - Boiling.
    - Frying.

CHAPTER XVIII.

THE DIGESTIVE APPARATUS.

THE TEETH.

218. **The Teeth** are firmly fixed in the sockets of the upper and lower jaws. (Fig. 31.) The exposed portions of the teeth are covered by a very hard substance, called *en-am'el.* (Fig. 29, [1].) The roots consist of bony matter (Fig. 29, [2]).

219. **Kinds of Teeth.**—The first set, which appears in

infancy, is called *tem'po-ra-ry*, or milk-teeth. They are twenty in number, ten in each jaw. Between six and fourteen years of age the temporary teeth are removed, and the second set appears, called *per'ma-nent* teeth. They number thirty-two, sixteen in each jaw (*a*).

220. The four front teeth in each jaw are called *in-ci'sors* (cutting-teeth); the next tooth on each side, the *cus'pid* (eye-tooth); the next two, *bi-cus'pids* (small grinders); the next two, *mo'lars* (grinders). The last one on each side of the jaw is called a *wisdom-tooth*,

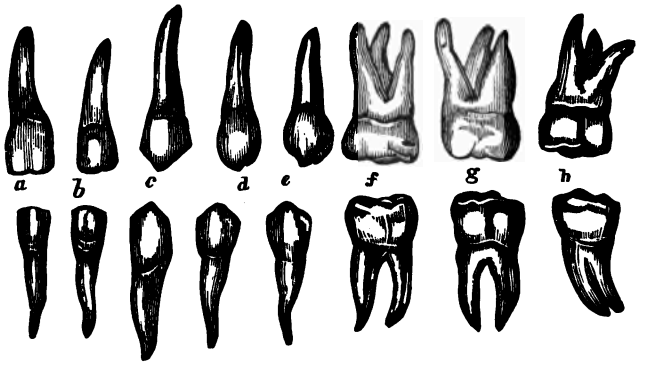

FIG. 27. THE PERMANENT TEETH OF THE UPPER AND LOWER JAW.—*a*, *b*, The incisors. *c*, The cuspids. *d*, *e*, The bicuspids. *f*, *g*, The molars (double teeth). *h*, The wisdom-teeth.

because it does not appear until a person is about twenty years old. (Fig. 27.)

221. *The use of the teeth is threefold:* (1) They divide the masses of food into smaller pieces, so that they are more easily and readily changed in the stomach. (2) They

aid us in speaking with distinctness certain letters and words. (3) They give beauty to the lower part of the face. When they are removed, the lips and cheeks sink in, as is frequently seen in old age.

HYGIENE OF THE MOUTH.

222. *Toothpicks are useful in removing any particles inaccessible to the brush.* They may be made of bone, ivory,

FIG. 28. A SIDE VIEW OF THE BODY AND ENAMEL OF A FRONT TOOTH.

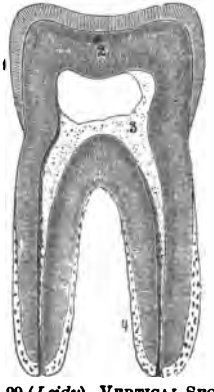

FIG. 29 (*Leidy*). VERTICAL SECTION OF A MOLAR TOOTH.—1, Enamel. 2, Dentine. 3, The wall of the pulp-cavity. 4, Cement.

or the common goose-quill. Metallic toothpicks should not be used, as they injure the enamel.

223. *The whole mouth should be washed with pure, tepid water*, at night, as well as after each meal, after which the teeth should be brushed upward and downward, both on the rear and front surfaces. It may be beneficial to

use refined soap once or twice every week, to remove any corroding substance that may exist around the teeth, care being taken to rinse the mouth thoroughly after its use.

224. *Food or drink should not be taken into the mouth when very hot or very cold.* Sudden changes of temperature may crack the enamel, and, finally, produce decayed teeth. *Smoking is injurious*, because the teeth are subjected to an alternate inhalation of cold air and warm air.

Observations.—(1) It is not always necessary to have teeth extracted when they ache. The nerves of the face may be diseased, and the tooth still be sound. (2) When it is necessary to have decayed teeth filled, it is better for the health of the person and durability of the teeth to have them filled with *gold foil.*

(*a*) FOR THE TEACHER. **Directions for Examination of the Mouth Parts.**—Request a boy having a good set of teeth to stand before the class. Call attention to the *lips:* line of junction of skin and mucous membrane. *Dental arch:* upper and lower jaw,—the gums, order of teeth from the median line,—*incisors*, *cuspids*, *bicuspids*, and *molars;* variations in the cutting and grinding surfaces; points of decay. *Movements of the lower jaw:* forward, backward, to the right or left, and combinations of movements. Place the finger in front of the ear, then move the jaw slightly, then stretch open; notice the degree of motion. *Hard palate:* notice its hard surfaces, with ridges, the soft posterior portion terminating in the soft palate, or *uvula*. *Tongue:* its free apex, its bridle, its veins prominent on the lower surface. On its upper surface note the numerous *papillæ*. Observe the variety of movements which the tongue can execute. *Throat:* request the boy to stand in the sunlight, mouth wide open, head slightly thrown back, and then to articulate slowly, Ah—ah—h—h. Thus the *soft palate* will be elevated, the palatine arches widened, and the throat parts brought into view; the *soft palate* in the middle line, over the dorsum of the tongue; the right and left *anterior pillars;* behind them the right and left almond-shaped *tonsils*, then the *posterior pillars* and the posterior wall of the *pharynx* in the central field.

Observe that the mouth and pharynx are lined with *mucous membrane*, and that the surfaces are bathed with *mucus*. If the mouth is suddenly opened, a jet of fluid may come from near the second upper molar tooth,—*saliva* from the *duct of Stenо* (parotid), or, if the tongue is raised, from *Wharton's ducts*.


OCCIPITO-FRONTALIS
TEMPORAL
ORBICULARIS PALPEBRARUM
MASSETER
LARYNX
TRACHEA
TRAPEZIUS
DIAPHRAGM
STOMACH
TRANSVERSE COLON
SMALL INTESTINE
RECTUM
BICEPS
BRACHIALIS
RECTUS FEMORIS
SARTORIUS
VASTUS INTERNUS
PATELLA
GASTROCNEMIUS
SOLEUS
TIBIALIS
KILBURN SC

FIG. 30.

CHAPTER XIX.

THE DIGESTIVE APPARATUS—Continued.

ANATOMY OF THE DIGESTIVE ORGANS.

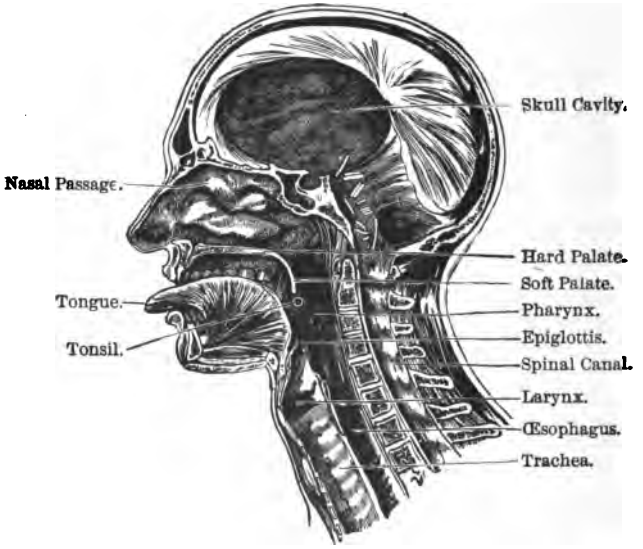

FIG. 31. VERTICAL SECTION OF THE HEAD.

225. The Digestive Organs are the *Mouth*, *Teeth*, *Sal'i-va-ry Glands*, *Phar'ynx*, *Œ-soph'a-gus* (gullet), *Stomach*, *In-tes'tines* (bowels), *Liv'er*, *Pan'cre-as*, and *Intestinal Glands* (*a*).

226. The Mouth is an irregular cavity, which contains the teeth and the tongue. (Fig. 31.)

227. **A Mucous Membrane** lines the digestive canal. It is thin in texture. In the mouth it is red in color.

228. **The Pharynx** (far'inks) is a muscular, membranous sac that leads to the œsophagus. (Fig. 31.)

229. **The Œsophagus** (e-sŏf'a-gŭs) is a large, membranous tube through which the food and drink pass into the stomach. (Fig. 31.)

230. **The Stomach** (stum'ak) is on the left side of the body, below the diaphragm (di'a-fram). (Fig. 30.) It is bag-like and composed of four coats. The middle coat is made up of muscular fibres. The inner coat contains secreting glands.

231. **The Intestines** are divided into two parts, the *small* and the *large*. The small intestine is about twenty-five feet in length. The large intestine is about five feet in length. (Fig. 32.)

CHANGES INDUCED BY ALCOHOL.

232. The mucous membrane lining the *œsophagus* may become thickened as the result of the excessive use of alcohol.

233. As a result of the daily use of strong alcoholics for a long time the walls of the *stomach* become thickened, more or less hardened and "leathery" to the feel. The secreting glands are often compressed. Fatty spots become visible here and there.

234. In old topers a thickened condition of the walls of the *small intestines* is sometimes seen; also, as in the stomach, a coating of thick slime.

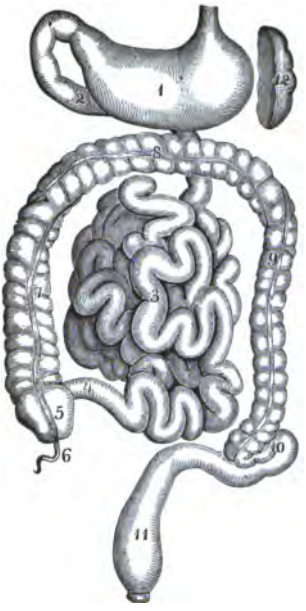

FIG. 32 (*Leidy*). A PORTION OF THE ABDOMINAL ORGANS.—1, *Stomach*. 2, 3, 4, *Small Intestine* (2, Duodenum; 3, Ileum; 4, Ileo-cæcal portion). 5, 7, 8, 9, 10, 11, *Large Intestine* (5, Cæcum; 6, Vermiform appendix; 7, Ascending colon; 8, Transverse colon; 9, Descending colon; 10, Sigmoid flexure; 11, Rectum).

THE ABSORBENTS.

235. The Lacteals are minute vessels which commence in the mucous surface of the small intes-

FIG. 33 (*Leidy*). VIEW OF THE GREAT LYMPHATIC TRUNKS.—1, 2, Thoracic duct. 4, The right lymphatic duct. 5, 6, 7, 8, Lymphatics.

tine. From the intestine they pass through small glands (*mes-en-ter'ic*) to the thoracic duct. (Fig. 37, [4, 3].)

236. The Thoracic Duct (Fig. 33, [1, 2]) commences behind the liver and ascends in front of the spinal column. In the neck it turns downward and forward, and ends in the vein behind the collar-bone. (Fig. 33, [3].)

237. The Lymphatic System consists of a vast system of minute tubes, called *lymphatics* (lim-fat'iks), found in most organs and parts of the body. At intervals in the system (notably at elbows, arm-pit, groin, back of neck, and in the abdomen) are found enlargements, called *glands*. (Fig. 33, [5, 6, 8].) The *lacteals* are a part of this system (235). The *lymph* (limf) is like blood in its nature, except that it contains no red corpuscles.

(*a*) **FOR THE TEACHER. Directions for Dissection.**—Secure the animal (preferably a dog or cat; a rat may be used) on its back by means of blocks. Make an incision through the skin from the sternum to the pubes. From near the *umbilicus* (navel) make two incisions at right angles to the first, extending nearly to the *lumbar vertebral processes*. Fasten back the skin after it has been dissected from the underlying muscles. Observe the pale *abdominal muscles*.

With scissors divide in the median line the walls. A large cavity, lined by a smooth, moist membrane, the *peritoneum*, is exposed. This membrane lines the abdominal cavity, and is reflected over the intestines and organs contained therein, and serves to keep the latter in their proper places. (Fig. 21.)

Remove the skin from the neck region. Note the large, light-brown, lobulated *salivary glands*, which meet near the middle line. The members of one pair, *submaxillary*, are located near the lower jaw; the members of the *parotid* pair reach from near the ear to the lower jaw. The *duct* of the latter passes forward over the face to near the angle of the mouth, where it enters the cheek-muscles; that of the former passes forward into the mouth, and is brought into view by dividing the lower jaw. You may be able to find the *sublingual glands* under the tongue.

Without cutting or tearing, but by simply turning over or pulling aside, trace the *alimentary canal* from near the left inferior side of the diaphragm, viz., the narrow *œsophagus*, the dilated *stomach*, the convoluted *small intestine*, the large, dark, sacculated *cæcum*, with its worm-like *appendix*, the *large intestine*, containing balls of excrement, and the *rectum*. Trace out the *mesentery*, made of two folds of the peri-

toneum, enclosing blood-vessels, lymphatics, and nerves, which connect the alimentary canal to the vertebral region. If the dog is in good condition, a loose, mesenteric, fatty apron, the *great omentum*, will be seen hanging from the lower border of the stomach. Notice the dark-purple-colored long body lying near the broad end of the stomach, the *spleen*. Observe the form, the lobes, the tubes entering, and the attachments of the large, dark-red, solid organ, the *liver*. Now turn over the stomach, slightly stretch the small intestine, and notice within the mesentery the long, hammer-like, pale-red, lobated *pancreas*. Trace the *duct* from the pancreas to its entrance into the small intestine, about a foot from the stomach.

Turn the stomach and intestines to the left side. Trace the flaccid tubes (containing dark-maroon blood) from the mesentery, spleen, and stomach, until they unite in a single trunk, the *portal vein*, which is seen to enter the liver. Turn the dark-red liver up towards the diaphragm, and its greenish *gall-bladder*, with its *cystic duct*, and the *hepatic duct* (from the liver), forming one *common duct*, will be brought into view.

Remove the intestines and stomach and the solid organs. Observe the form, color, consistence, and weight of each organ. Cut into the *liver* and observe its peculiar structure and the amount of blood still present. Cut open the *spleen*. Note its fibrous investment, its pulpy contents, and the absence of a duct. Separate the long, pale-red *pancreas*, and note its friable, lobulated character.

Observe to the right and left of the backbone a compact, roundish, solid organ, invested by areolar tissue holding fat, the *kidney*. Notice the *ureter*, a pale, firm-feeling duct, running from a depression in the kidney towards the middle line into the *pelvis*, and ending in the *bladder*. Tear the kidney out of its sheath. Lay open the kidney by a longitudinal incision parallel to the flat side.

CHAPTER XX.

THE DIGESTIVE APPARATUS—Continued.

THE GLANDS.

238. A Gland is a soft solid. It is made up of secreting "gland-cells," held in place by meshes of fine white fibres (*connective tissue*). It has an abundance of blood-tubes.

239. The Salivary Glands are six in number,—three on each side of the face. Their ducts discharge into the mouth (219 *a*).

Observation.—In "mumps," one or both *Parotid* (salivary) *glands* may become enlarged, and even painful. (Fig. 1.)

240. The Liver (Fig. 30) is in the right side of the

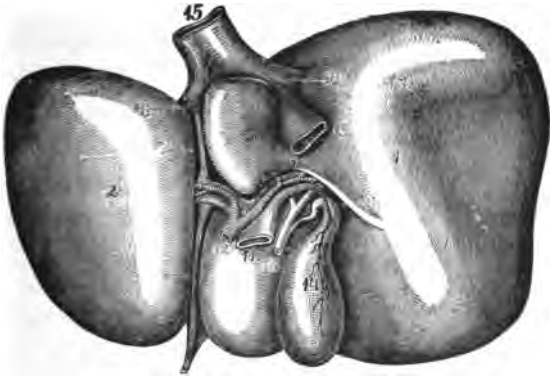

FIG. 34. THE LIVER.—1, Right lobe. 2, Left lobe. 11, Portal vein. 13, Common bile-duct leading to the small intestine. 14, Gall-bladder. 15, Vena cava ascendens.

body, below the diaphragm. On the under side of this organ is the *gall-bladder* (Fig. 34, [14]), which contains a yellow, bitter fluid, called *bile.*

241. The Pancreas is a long, flattened organ, situated behind and below the stomach. (Fig. 36, [4, 5].)

242. The Gastric Glands are minute tubes, seated in the walls of the stomach.

243. The Intestinal Glands are mucus-secreting pits, seated in the mucous membrane lining the intestines.

ADDITIONAL ABDOMINAL ORGANS.

244. The Abdomen is the cavity below the diaphragm, and is walled in by layers of muscles. (Fig. 1.) The *per-i-to-ne'um* is a membrane lining the abdomen.

245. The Spleen (milt) is an oblong, flattened organ, situated in the left side, in contact with the stomach and pancreas. (Fig. 36, [8].)

246. The Kidneys, two in number, are dark-red, solid glands. They are found in the back part of the abdomen. (Fig. 1.) The *ureter* (Fig. 35, [5]) is the tube which conducts the secretion of the kidney to the *bladder*. (Fig. 1.)

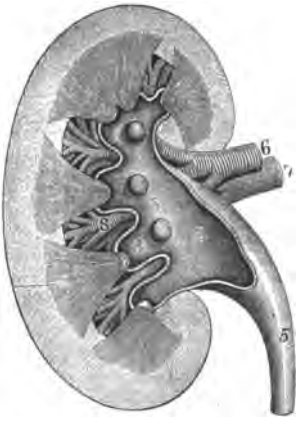

FIG. 35. LONGITUDINAL SECTION OF A KIDNEY.—5, Ureter. 6, Renal artery. 7, Renal vein.

CHANGES INDUCED BY ALCOHOL.

247. *The gastric glands*, in old topers, are so changed by the action of alcohol that they appear as hard, projecting granules. They are wholly unfitted for their proper work.

248. Among Americans who have used alcohol in excess for years, the *liver* is most often enlarged and fatty; occasionally it is smaller and harder (*cirrhosis*) than normal. (*Formad.*)

249. In almost every case where old topers (American)

have been examined, the *kidneys* have been found to be hard, fibrous, and much smaller than in other cases.

250. A fatty degeneration of the *pancreas* has been observed in the examinations of the bodies of inebriates.

CHAPTER XXI.

PHYSIOLOGY OF THE DIGESTIVE APPARATUS.

PHYSIOLOGY OF THE GLANDS.

251. **The Function of a Gland** is to separate from the blood materials already in the blood, as salt; or, in its gland-cells, to make from the blood something quite different from the blood, as milk, bile, etc.

252. **The Product of a Gland** is called its *se-cre'tion.* The secretions are mostly fluid. Their color, density, taste, and strength vary largely.

253. **The Secretion** of the salivary glands (239) is called *sa-li'va;* of the mucous membrane (227), *mu'cus;* of the stomach-glands (242), *gas'tric juice;* of the pancreas (241), *pan-cre-at'ic juice;* of the liver (240), *bile;* of the intestinal glands (243), *in-tes'ti-nal juice;* of the kidney (246), *urine;* of the sweat-glands (104), *per-spi-ra'tion;* of the oil-glands (105), *se'bum;* of the mammæ, *milk;* etc. Most secretions are of use within the body, as saliva, bile, etc.; others are waste materials to be cast out of the system, as urine, perspiration, etc.

254. **The Liver** is the largest and busiest gland of the

body. It makes *bile;* forms *glycogen* (glīk'o-jen) from the blood and stores it up until it is needed to feed other parts; works over and *changes the shape of the proteids* received in the food; and aids in casting out *nitrogen wastes.*

255. **The Kidneys** are the most important glands. Their work is to cast out the *nitrogen wastes* and *mineral wastes* of the body. Most *poisons,* as well as the *active parts* of tea, coffee, spices, etc., are cast out by the kidneys.

Observation.—If the secretion of urine ceases for about fifty hours, sufficient waste materials and poisons (made in the body) will accumulate to cause death. (*Bouchard.*)

256. *The casting out of the greater part of the alcohol not burnt in the system is done by the kidneys.* As it passes through the kidneys it irritates and even inflames these glands, causing acute Bright's disease.

257. **The Spleen** acts during the digestive hours as a storage-place for a large amount of blood. It is probably concerned in the making of the blood-corpuscles.

258. **Injurious Agents and the Glands.**—*Opium* acts to diminish most secretions, and even to stop them; *tobacco* modifies the quantity and nature of the digestive juices; *alcoholics,* varying with the kind and amount taken, sometimes increase and sometimes diminish the secretions; and the *active parts of tea, coffee,* etc., according to the amount taken, may increase or may diminish the secretions.

PHYSIOLOGY OF THE DIGESTIVE ORGANS.

259. The Food, whether animal or vegetable, has no resemblance to the bones, muscles, and other parts of the body to which it gives sustenance. It must undergo certain essential alterations before it can become a part of the different structures of the body.

260. In the Digestive Canal the solid portions of the food (cooked and uncooked) are reduced to a fluid state. The liquid portions are prepared so that they can pass through moist membranes.

261. *The first change in the food is made in the mouth* by the teeth and the *sa-li'va* (spittle) from the salivary glands. The teeth divide the food, while the saliva moistens and softens it. The saliva changes a part of the starch of the food to sugar (*a*).

262. In Swallowing, the food is pressed by the tongue and other muscles into the pharynx, from which it is forced into the œsophagus. (Fig. 31.) As soon as the food is received into the œsophagus its muscular coat contracts upon it successively from above downward, and the food-mass is pressed onward into the stomach. (Fig. 32, [1].)

263. *The next change in the food occurs in the stomach.* The muscular coat of the stomach contracts, and the food is moved around, while, at the same time, a peculiar fluid is supplied by the stomach, called *gastric juice*, which mixes with the food and reduces it to a soft, pulpy mass. The *pepsin* of this juice converts the insoluble proteids (183) into soluble *pep'tones.*

264. *Into the upper portion of the small intestine* a part of this pulpy, grayish mass is passed, and, by the action of the bile and pancreatic juice, it is changed into a milk-like substance, called *chyle.*

Observation.—Oil will not mix with water. Oil will not pass through a moist membrane. The bile, the pancreatic and intestinal juices so change the oils and fats of the food that they will mix with water, as milk will mix with water. The chyle thus can pass into the lacteals (235).

265. In the *small intestine* not only are *fats and oils* prepared for absorption, but *starches* are changed to sugars, and *proteids* to peptones. That is, all kinds of foods are digested in the upper part of the small intestine.

266. Summary of Digestion.—

In the mouth:

Crushing, dividing, and softening.

Starches partly changed to sugar.

In the stomach:

Thorough mixing and churning of foods.

Fats, starches, and proteids set free.

Proteids changed to peptones.

In the small intestine:

Starches changed to sugars.

Proteids changed to peptones.

Oils and fats digested.

(*a*) **Experiment.**—Wipe the mouth carefully. Place a bit of dry bread on the tongue. Move the lower jaw a few times. As the bread becomes moist it also becomes sweet in taste.

CHAPTER XXII.

PHYSIOLOGY OF THE DIGESTIVE APPARATUS—Continued.

PHYSIOLOGY OF ABSORPTION.

267. Absorption is the process by which the nutrient portion of the food is removed from the digestive canal to be conveyed into the blood-tubes.

268. The Mucous Membrane of the digestive canal is studded with blood-tubes. Hence *water* and *materials soluble in water* are absorbed from the mouth, gullet, stomach, and intestines.

269. A part of the *sugars* (starch is insoluble) and of the *peptones* (proteids are insoluble in water)

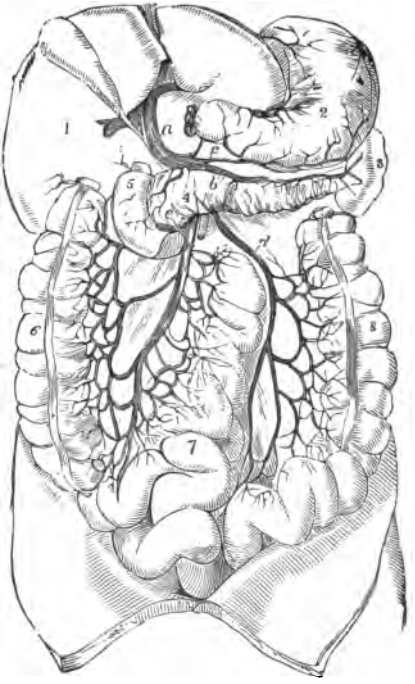

FIG. 36 (*Leidy*). THE PORTAL SYSTEM.—1, Liver. 2, Stomach. 3, Spleen. 4, Pancreas. 5, 7, Part of small intestine. 6, 8, Part of large intestine. *a*, Portal vein. *b*, Splenic vein. *c*, Vein from stomach. *d*, *e*, Veins from intestines.

enter the blood-vessels of the *stomach* (Fig. 36, [c]) and go directly to the liver (*portal vein*, [a]).

FIG. 37. A VERTICAL SECTION OF THE TRUNK.—1, The vertebral column. 2, 2, 2, Lacteals and mesenteric glands. 3, 3, 3, Thoracic duct, commencing in the lacteals and ending in the subclavian vein, 11. 4, Stomach. 5, Large intestine. 7, Liver. 8, 8, Diaphragm. 9, Heart. 10, 10, Lungs. 11, Vein at base of neck.

270. It is from the *small intestine* that most of the nourishing materials pass into the blood-tubes. The *water*, *minerals*, *sugars*, and *peptones* pass from the intestinal veins to the liver. (Fig. 36, [c, d, e].)

271. The Lacteals suck up the digested *oils* and *fats*. The latter undergo changes in the mesenteric glands (Fig. 37, [2, 2]), mix with lymph (237) in the *thoracic duct* (Fig. 37, [3, 3]), and enter the blood at the base of the neck. (Fig. 37, [11].)

272. In the *large intestine* accumulate the *undigestible portions* of the food and the *wastes* taken from the blood by the glands of the lower bowels. The amount of the excreta varies with the nature and the quantity of the food. A vegetable diet affords more waste materials than a mixed diet, and a mixed diet more than a flesh diet.

273. Summary of Absorption.—

From the mouth and œsophagus:

Water, minerals, sugars.

From the stomach:

Water, minerals, sugars, peptones.

From the small intestine:

(*a*) Veins,—water, minerals, sugar, peptones.

(*b*) Lacteals,—digested oils and fats.

From the large intestine:

Water, minerals.

274. The Function of the Lymphatics (237) is to gather up the stray drops of fluid and particles of waste in the tissues and to convey them again into the blood-current. *The Lymphatic glands* work over this material and fit it to enter the blood again. They also serve to retard the entrance of poisons into the blood.

Observation.—When a person's arm is cut with a filthy knife, the lymphatics running from the wound up the arm may appear as painful, red lines, and the "glands" at the elbow and armpit become swollen and tender. Later the blood becomes infected, because the lymph enters the blood at the base of the neck. (Fig. 33, ^{3,4}.) In *vaccination* the lymphatics absorb and convey the vaccine to the blood. In many cases red lines extend from the place of vaccination up the arm to the enlarged and painful glands in the axilla. *In the majority of cases of thorough vaccination, absolute and complete protection against smallpox is established. Re-vaccination is necessary every five or six years.*

INFLUENCE OF INJURIOUS AGENTS ON DIGESTION.*

275. The Action of the Appetizers, Tobacco, and Alcoholics on the digestive function varies with the *amount* taken, the *conditions* under which taken, the *time of taking*, and the *quality* (*a*) of the agent taken.

276. The Appetizers (187) contain hot, pungent active parts. They excite an increased flow of *saliva* and of *gastric juice*. When used in moderation they may, in some adults, aid digestion. They, however, must be used in increasing amounts in order to get the desired effect.

Observation.—The Koreans use large amounts of peppers and other pungent vegetables. It is rare to find a young adult Korean who is not suffering from inflammation of the stomach due to the appetizers used.

277. Tea, even weak tea (213), exercises a very marked slowing action on *salivary digestion*. This is due in a large measure to the tannin always present. It remarkably retards *peptic digestion*,—more than an equal amount of coffee (*b*). It slows the *pancreatic digestion* of starches (*c*).

278. Tobacco-Chewing causes the *salivary glands* increased work. The reports of the effects of tobacco (chewed, smoked, or snuffed) on the *digestive function* of adults are conflicting. Dr. W. B. Richardson affirms that the stomach is debilitated and difficult digestion is

* Adapted largely from Professor Yeo's summary of the experiments of Sir William Roberts, M.D., on the influence of "Food Accessories" on the chemical acts of digestion, 1885.

induced through its general action on the system. All agree that it is injurious to the digestive function in the growing body.

279. **Opium** acts to diminish the secretion of all glands. Hence the giving of "Soothing Syrups" must retard digestion. The younger the person the more pernicious is the action of opium (440).

280. **The Absorption of Alcohol** takes place from the mouth, throat, and stomach. Little or none ever reaches the intestine to be absorbed. Hence the direct action of alcoholics is limited to the salivary and gastric digestions.

281. **Malt Liquors**, if free from acidity, interfere little with *salivary digestion* in adults; they retard *peptic digestion* more than an equivalent amount of alcohol diluted. They (in the stomach) so influence the starches that *intestinal digestion* is made more difficult.

282. **Wines** (sherry, hock, claret, port), even in small amounts, retard *salivary digestion.* This is due, not to the alcohol, but to the acid of the wines. Small quantities slightly interfere with *peptic digestion;* ordinary drams notably slow the action of the pepsin.

Observation.—Pickles, salads, vinegar, and acid fruits remarkably slow the digestion of bread and other starchy foods. This is due to their acids. Hence it is that the free use of vinegar often prevents a person from becoming plump.

283. **Spirits**, when used (by adults) in moderation and well diluted, often aid *salivary digestion.* Brandy, owing to the presence of tannin, retards the digestion of

starches. Small quantities of dilute alcohol favor *peptic digestion*, moderate quantities slow it, and large quantities stop it, owing to its strong, direct, paralyzing action on the pepsin.

(*a*) **The Wines** made by flavoring potato-alcohol, or "fortifying" pure wines with beet-root or corn alcohol, are more injurious than a fermented grape-juice (216) containing the same percentage of alcohol. (*Lunier.*) (Chap. XXXII. *a*.)

(*b*) **Cocoa** (211) exerts little or no influence on *salivary digestion*. As commonly taken, it exerts no appreciable effect on *peptic* (stomach) *digestion*. Being rich in fatty matters, it increases the work of *intestinal digestion*.

Coffee (212), taken in medium strength, only slightly retards *salivary digestion*, yet markedly retards *peptic digestion*. Black coffee (*café noir*) exerts a very powerful retarding effect on gastric digestion.

"**After-Dinner Coffee.**"—In the case of some adults the after-dinner cup of coffee does not retard the digestion of a too elaborate dinner,—it may assist by its nervous stimulation.

(*c*) **Tea-Tippling** is a fertile cause of dyspepsia, characterized by acidity of the stomach, eructations of gas, heart-burn, nervousness, peevishness, and irritability. This trouble is very common among women who live on bread and tea,—especially tea.

CHAPTER XXIII.

HYGIENE OF THE DIGESTIVE APPARATUS.

284. Quantity of Food.—*The child and youth require food to promote the growth* of the bones, muscles, and the different parts of the body. The more rapid the growth of the child, the greater the demand for food. This accounts for the keen appetite and vigorous digestion in childhood.

285. *Well-clothed children require less food in cold weather than those thinly dressed.* "Our clothing is merely an equivalent for a certain amount of food." (*Liebig.*)

286. *Food is necessary to repair the waste which attends the functions of the different organs.* The waste is greatest when we exercise most. For this reason, when we increase our exercise or labor, the quantity of food may be increased.

287. *A change of occupation often demands a lessening of the amount of the food,* as when the girl leaves the active household employments for the shop of the dress-maker, when the boy leaves the farm for the school-room, when the hard-working person "goes on a visit."

Observation.—Self-denial or abstinence from food for twelve or twenty-four hours is an antidote for most "sick headaches."

288. *If the digestive organs are weakened or diseased, only a small quantity at a time should be taken.* Food does not invigorate the system except it is changed, enters the blood, and is utilized by the system. Foods which are not soon absorbed undergo putrefactive changes in the digestive canal, inducing the formation of offensive gases, discomfort, and colicky pains.

289. *Appetite is a safe guide,* as to the amount, when a person is in health, when the food is simple and natural in kind and in quality, and when its preparation is plain. The more artificial the food, the more it is sugared, flavored, and spiced, the more a person is tempted to overeat (*a*).

290. Quality of Food.—*The food should be in the form of plain foods,* meats, fish, eggs, milk, bread, rice, vegetables, and ripe fruits, plainly served. Fashionable dishes and tidbits are inadequate.

291. *The influence of season and climate should be considered in selecting food.* By abstaining from meats, stimulating drinks, and "made drinks" in warm weather, and living on nutritious, plain, vegetable foods, the "season" or bowel complaints may be in a great degree prevented.

292. *The age of persons modifies the influence of food on the system.* The organs of a child are more sensitive and excitable than those of a person advanced in years. A vegetable diet (oatmeal, whole wheat, hominy, fruits, etc.) with milk is most appropriate for a child.

293. Manner of Eating.—*Food should be taken at regular periods.* The interval between meals should be regulated by the kind of food, the age, health, exercise, and habits of the individual. Children require food more frequently than adults.

294. *Food should not be taken too frequently.*—If food is taken before the stomach has regained its tone and energy by repose, or before the digestion of the preceding meal has been completed, not only will the action of the stomach be imperfect, but the food partially digested becomes mixed with that last taken, inducing irritation (288).

295. *Food should be well masticated, or chewed.* All solid food should be reduced to a state of comparative fineness by the teeth before it is swallowed; the gastric fluid of the stomach will then blend with it more readily, and act more vigorously.

Observation.—New bread is less digestible than stale bread, because the crumb is soft, elastic, and sticky, and

the digestive juices are slow in permeating the mass. "Toasted bread" and "pulled bread" are to be commended.

296. *Food should be masticated and swallowed without drink.* As the salivary glands supply fluid to moisten the dry food, the use of tea, coffee, water, or any other fluid is not demanded by nature's laws while taking a meal (*b*).

Observation.—Prince Bismarck is reported to have been relieved from a most troublesome dyspepsia by confining himself to one kind of meat at each meal, by abstaining from beer, and by taking no fluid at meal-time, drinking freely from three to four hours after the meal.

297. *Ice-water, taken with food, or soon after, hinders digestion.* First, it lowers the temperature of the stomach, thus checking the secretion of gastric juice; second, it slows the change of proteids into peptones.

(*a*) **Diet, Alcohol, and Disease.**—"I have for some years past been compelled by facts, which are constantly coming before me, to accept the conclusion that more mischief in the form of actual disease, of impaired vigor, and of shortened life accrues to civilized men, so far as I have observed in our own country and throughout western and central Europe, from *erroneous habits in eating* than from the *habitual use of alcoholic drink*, considerable as I know the evil of that to be. I am not sure that a similar comparison might not be made between the respective influences of these agencies in regard of moral evil also." (*Sir Henry Thompson, M.D.*, 1885.)

(*b*) **Theism.**—"A large number of diseases owe allegiance to Queen Thea." (*M. Eloy.*) The diseases excited by tea are characterized by a predominance of nervous symptoms, as "nervousness," headache, palpitation of the heart, and of gastric symptoms, as loss of appetite, pain in the region of the stomach, nausea, dyspepsia, etc. "The *irritability* that overtakes women so frequently may sometimes be clearly traced to an excessive indulgence in 'afternoon tea.' Theism belongs to that class of diseases in which morphinism, caffeinism, and vanillaism are found. The *habit of tea-drinking* is one that grows on its victim like the similar ones of opium and alcohol. Taken in strict moderation, and with due precautions in the mode of making, tea is, like alcohol, a valuable stimulant; in its abuse there is also a certain analogy." (*Lancet*, 1886.)

CHAPTER XXIV.

HYGIENE OF THE DIGESTIVE APPARATUS—Continued.

298. **The Condition of the System.**—*Food should not be taken immediately after severe exertion, either of the body or mind;* for all organs in action require and receive more blood than when at rest.

Observation.—The practice of students going immediately from severe mental labor to their meals is a fruitful cause of indigestion and mental debility. The custom of farmers and mechanics hurrying from their toil to the dinner-table, "to save time," does much to cause dyspepsia among these classes in the community. It would be well if school-children, especially in warm weather, could have a two-hours' nooning.

299. *Severe mental or physical labor should not be entered upon immediately after eating.* The amount of blood supplied to the stomach and alimentary canal during the digestion of food is increased, and a deficiency consequently exists in other organs. If the blood is diverted from the stomach to the limbs or brain by active exertion the action of the digestive organs will be slowed, if not stopped.

Illustration.—An English gentleman fed two dogs upon similar articles of food. He permitted one to remain quiet in a dark room; the other he sent in pursuit of game. At the expiration of one hour he had both killed.

The stomach of the dog that had remained quiet was nearly empty. In the stomach of the dog that had used his muscles in chasing game the foods remained nearly unaltered.

300. *Pure air is necessary to give a keen appetite and vigorous digestion.* The digestive organs not only need the stimulus of blood, but they absolutely need the influence of pure blood, which cannot exist in the system except when we breathe pure air.

Illustration.—A manufacturer stated before a committee of the British Parliament that he removed an arrangement for ventilating his mill because he noticed that his men ate much more after his mill was ventilated than previous to admitting fresh air into the rooms!

301. *The custom of taking the principal meal at mid-day, especially in warm weather, is not a good custom.* It would be better to take a light, cool mid-day repast and to enjoy *at leisure* the principal meal from one to two hours after the end of the day's work.

302. *When travelling in coaches or cars the stomach is not in a state to digest large quantities of food.* When food is taken, it should be of the mildest character and small in quantity.

303. *To prevent disease*, it is as necessary that the alimentary canal be evacuated regularly as that we take food into the stomach at regular periods. *Constipation*, which is so common among females and sedentary men, is largely due to a want of sufficient liquid in the intestinal canal (204).

INJURIOUS AGENTS.

304. Confectionery, *even when made of pure materials and honest flavors, is an improper article for children, youth, and young adults.* Candies often act injuriously on the teeth, derange the action of the stomach, and educate a craving for stronger stimulants.

305. Pepper, Mustard, and Spices *are simple spurs.* They of themselves do not nourish. They ought not to be used in the preparation of children's food. They ought to be used less freely by adults.

Observation.—A fertile cause of disease in hot climates (India, Africa, and Central America) is the taking of large amounts of meats, highly-spiced foods, beer, and heavy wines.

306. *Coffee and tea are not needed by children,* hence they should be excluded from their diet. Milk and water are the only drinks advisable for children and youth.

307. *Tea and bread.* It is impossible to make tea without its having a large percentage of tannin. Tannin hinders the digestion of starches. Hence it is best not to take bread and butter, or cake, with one's "five-o'clock tea" (*a*).

Observation.—Tea or coffee, while, as a rule, they do no harm to healthy adults when used in moderation and well diluted, act injuriously on most "dyspeptics."

308. *Opium.* The custom of giving "Soothing Syrup" to a crying, fretting child under all conditions is bad (277). The infant's dependence upon and craving for

opium may lead to the youthful desire for tobacco and alcoholics.

309. *As tobacco does not aid digestion in the young*, as its use is attended with injurious effects on the growing child and youth (278), it should certainly not be used by the immature.

310. *A healthy person needs no alcoholics.* The constant use of alcoholics by a well-fed person is not necessary; too often it is harmful.

311. *Beer, wines, and spirits should not be used by the immature.* Not only do they hinder digestion (281), but they pave the way to ill health, inefficiency, and moral and mental degradation.

(*a*) **The Japanese Method of Drawing Tea** is preferable to the American. Heat the water to near the boiling-point, and allow it to cool down to the sipping temperature. Pour this water on to a generous amount of pure, well-fired leaves, in a small porcelain pot. At once rinse the small cups with warm water. Then serve the warm infusion. Such tea is clear, invigorating, and free from bitterness.

GENERAL REVIEW QUESTIONS.

The Teeth.

Describe the teeth of an adult. (**218–220.**) Mention the uses of the teeth. (**221.**) How may the teeth be best preserved? (**222–224.**)

The Digestive Canal.

Describe the digestive canal. (**226–231.**) What structural changes are induced by alcohol,—(*a*) œsophageal, (*b*) gastric, (*c*) intestinal? (**232–234.**)

The Absorbents.

Describe the lacteals and the thoracic duct. (**235, 236.**) What is lymph? In what does it move? (**237.**)

The Glands.

What is a gland? (238.) Name and locate the digestive glands. (239–243.) Describe the abdomen. (244.) Speak of the spleen and kidneys. (245, 246.) What changes are induced by alcohol in the structure of glands? (247–250.)

Functions of Glands.

What is the proper work of glands? (251, 252.) How do gland duties vary? (253.) What is the work of the liver? (254.) Mention the duties of the kidneys. (255, 256.) What agents interfere with gland action? (258.)

Physiology of Digestion.

What changes occur in the digestive canal? (259, 260.) What changes occur in the mouth and stomach? (261–263.) In the intestines? (264, 265.) Write a summary of digestion. (266.)

Physiology of Absorption.

What portion of the digested food is absorbed by the veins? (268–270.) What do the lacteals do? (271.) Write a summary of absorption. (273.) Mention the duties of the lymphatics. What occurs in vaccination? (274.)

Actions of Injurious Agents.

What varies their influence? (275.) Mention objections to "appetizers." (276.) Where does tea interfere with digestion? (277.) Give Dr. Richardson's views on tobacco. (278.) Why not freely use opiates? (279.) Where is alcohol absorbed? (280.) Compare the actions of beer and wine. (281, 282.) How does the dosage of alcohol affect the digestive function? (283.)

Hygiene of Digestion.

When should the amount of food be varied? (284–287.) When is food useful? (288.) When is appetite a safe guide? (289.) Mention suitable foods. (290.) How should the kind of food be

varied? (291, 292.) Mention some health-hints and reasons for the same. (293–295.) Why should fluid not be taken with food? (296, 297.) When ought food to be avoided? (298, 299.) Mention some dietetic suggestions. (300–303.)

Injurious Agents.

Mention objections to candies. (304.) Why are "appetizers" objectionable? (305.) When and by whom ought tea to be avoided? (307.) Give objections (digestive) to opium; to tobacco. (308, 309.) Why need alcoholics be used? (310, 311.)

BLACKBOARD ANALYTIC SUMMARY OF THE DIGESTIVE APPARATUS.

(Chapters XVIII.–XXIV.)

- ANATOMY OF . . .
  - *Teeth.*
  - *Digestive Canal* . . . .
    - Mouth.
    - Pharynx.
    - Œsophagus.
    - Stomach.
    - Intestines.
  - *Absorbents* . . . . .
    - Lacteals.
    - Mesenteric Glands.
    - Thoracic Duct.
  - *Lymphatic Absorbents.*
    - Lymphatics.
    - Lymphatic Glands.
  - *Digestive Glands* . .
    - Mucous.
    - Salivary.
    - Gastric.
    - Intestinal.
    - Pancreas.
    - Liver.
  - *Abdominal Glands* . .
    - Spleen.
    - Kidneys.

PHYSIOLOGY OF. .	*Digestion*	Gland Secretion. Chewing. Salivary Digestion. Swallowing. Gastric Digestion. Intestinal Digestion.
	Absorption	Venous. Lacteal. Lymphatic.
HYGIENE OF. . .		Suitable foods; Moderation in eating; Thorough chewing; Non-use of ice or fluids during eating; Quiet after eating; Regularity in eating; Exercise; Ready excretion (skin, kidneys, bowels); Avoidance of injurious agents.
AVOIDABLE CAUSES OF ILL HEALTH.		Alcoholic gland- and gastric-changes; Alcoholic slowing of digestion; Tobacco hinderance of digestion; Opium slowing of digestion; Candy- and "Appetizer-" indigestion; Coffee- or Tea-indigestion.

CHAPTER XXV.

THE RESPIRATORY APPARATUS.

ANATOMY OF THE RESPIRATORY ORGANS.

312. The Organs of Respiration are the *air-passages*, the *lungs*, and certain muscles.

313. The Air-Passages include the right and left *passages of the nose* (Fig. 31), the *phar'ynx*, or throat (Fig. 31), the *lar'ynx*, or voice-box (Fig. 31), the *tra'che-a*, or

windpipe (Fig. 31), the *bron'chi* (Fig. 39, [5, 6, 7, 8]), and the *air-cells* (Fig. 39, [9, 9]).

314. The Chest (thorax) is the ribbed portion of the

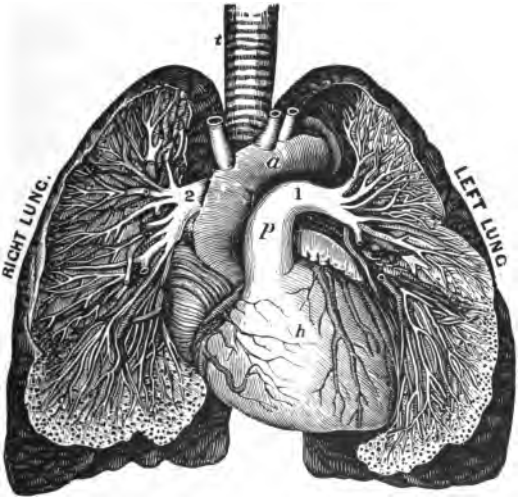

FIG. 38. THE HEART AND LUNGS.—*t*, The windpipe. *h*, The heart. *a*, The aorta. *p*, The pulmonary artery. 1, The branch of the pulmonary artery that divides in the left lung. 2, The branch that divides in the right lung.

trunk. It is made up of a cage-work of bones and cartilages (Fig. 4), filled in with muscles (Fig. 30). It contains the lungs, heart, and blood-tubes.

315. The Diaphragm (di'a-fram) is a broad, thin, nearly circular muscle, separating the thorax from the abdomen. (Fig. 30.) It is *the* muscle of respiration.

THE AIR-PASSAGES.

316. The Nasal Passages are two in number. They are separated from the mouth by the *hard* and *soft palates*

(Fig. 31), and from each other by a bone-and-cartilage partition.

317. The Pharynx (far'inks) is a passage-way with muscular walls. It is an air- and a food-passage (228).

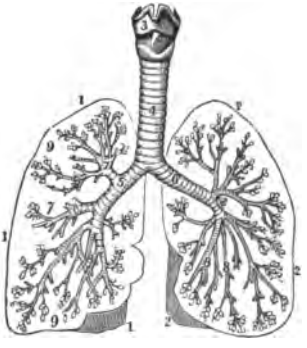

FIG. 39. THE BRONCHI.—1, Outline of right lung. 2, Outline of left lung. 3, Larynx. 4, Trachea. 5, 6, 7, 8, Bronchial tubes. 9, 9, Air-cells.

318. The Larynx (lar'inks) is made of plates of cartilage. (Fig. 45.) It opens above into the pharynx, and below into the trachea.

319. The Trachea (tra'ke-ah) is situated in the front part of the neck. It extends from the larynx ("Adam's apple") to the lungs. It is made up of partial rings of cartilage completed with membrane. It is an open flexible tube. (Fig. 39, 4.)

320. The Bronchi (bronk'ī) are the divisions of the trachea (Fig. 39, 5, 6.) These bronchi divide, upon entering the lung, into numerous small and smaller branches. (Fig. 39, 7, 8.)

321. The Air-Cells are minute sacs at the ends of the smallest divisions of the air-tubes. (Fig. 39, 9, 9.) In these walls the minute capillaries of the arteries of the lungs are found.

Illustration.—The trachea may be compared to the trunk of a tree; the bronchi to two large branches; the subdivisions of the bronchi to the branchlets and twigs;

the air-cells to the buds seen on the twigs in the spring. (Fig. 39.)

322. A Mucous Membrane (227), commencing at the outer opening of the nostrils, lines all the air-passages and all the air-cells.

Observation.—When the mucous membrane of a few of the larger branches of the windpipe is congested, the condition is called a "cold;" when inflammation arises and extends to the lesser air-tubes, bronchitis. *Coughing* is a violent expulsory effort, by which air is suddenly forced through the bronchi and trachea to remove offending matter.

THE LUNGS AND THEIR COVERINGS.

323. The Lungs, two in number, are conical in shape. (Fig. 30.) The color of these spongy organs is pinkish-gray, showing numerous black spots. They are made up of air-tubes, air-cells, and blood-tubes, held together by fine meshes of connective tissue.

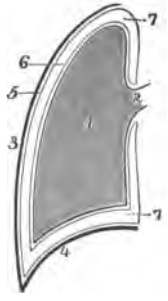

FIG. 40. DIAGRAM OF PLEURA IN SECTION.—1, Lung. 2, Root of lung. 3, Inner surface of chest. 4, Upper surface of diaphragm. 5, Outer surface of sac in contact with inner surface of chest. 6, The other outer surface of sac in contact with surface of lungs. 7, 7, Pleural cavity.

324. The Pleuræ are two thin-walled, closed sacs. They envelop the right and left lungs. The sacs contain a little fluid. (Fig. 40.)

Observation.—In *pleurisy* the inner surface of the sac

becomes roughened. Hence, when one raw inner surface rubs against the other inner surface during breathing, sharp pain is caused.

325. The Continuous Use of Alcoholics produces a change in the structure of the lungs ("condensation"). The short breath and wheezy breathing of "old topers" is well known. The lung, changed by alcohol, often, owing to a slight cold, becomes the seat of *alcoholic phthisis* (ti'sis), which is usually rapidly fatal. Alcohol, used in excess, induces thickening of the lining membrane of the larynx and bronchial tubes.

(*a*) FOR THE TEACHER. **Directions for Dissection.**—Open the thorax (chest) of a dog or rat, as directed in Chapter XIII. When the thorax is opened, air enters the pleural cavities; the lungs, which had hitherto filled the large right and left chambers of the thorax, shrink somewhat. Before removing the thoracic viscera, bend two straws of broom-corn into a sickle shape; pass one into each nostril, and then urge them gently forward to their whole length. Open the mouth, gently move the soft curtain attached to the back part of the roof of the mouth to one side, and the two straws will be seen projecting into a cavity or open sac, the *pharynx*. The passages in which the straws lie are separated from each other by a bony and cartilaginous septum, and from the mouth by bone and a soft, fleshy curtain. The latter is called the *uvula*, or *soft palate*, and the former the *hard palate*. If the musculomembranous pharynx be laid open, *five* openings will be easily seen: two leading to the nostrils, one to the mouth, one to the larynx, and one to the gullet. (The openings to the right and the left *Eustachian tube* (leading to the middle ear) may not be seen.

Cut the larynx free from the pharynx, raise it, and snip it free from the gullet just beneath. Place a tube in the larynx, tie it in, and inflate the lungs. Remove the tube, and note the *larynx*, an irregular cartilaginous box, opening above into a membranous sac, the *pharynx*, and below into a cartilaginous tube, the *trachea*. Observe on the upper front of the larynx a stiff, elastic, projecting, tongue-like mass, the *epiglottis*. Press this down, and it is seen to close over a slit-like opening in the larynx, the *glottis*.

The *trachea* is found to be nearly a complete cartilaginous open tube. The trachea divides into two partly cartilaginous tubes, the *bronchi*, which in turn, as a rule, divide and subdivide by twos. The cartilages in these latter soon disappear, they being represented only by membrane. The lumen of these tubes grows smaller and

smaller, and is lost to sight in the soft, elastic, pinkish mass called the *lung*. Note the divisions of the right and left lungs into *lobes* and divisions of lobes, called *lobules*.

Remove the trachea, lungs, and heart by cutting off the blood-vessels from the thorax. Place in the relative position and note: Entering the lung-mass, side by side with the bronchi, are seen the open, firm *arterial* tubes, and the numerous dark, thin, flattened *veins*. These bronchi, arteries, and veins, together with the accompanying nerves, lymphatics, and connective tissue, constitute the *root of the lung*. The smooth outer surface of the lung-mass is the *pulmonary pleura*. By a dainty scratch a portion of a thin membrane, the *pleura*, may be raised into view. The smooth lining of the empty thorax is the *parietal* pleura, and the moisture the *pleural fluid*. Squeeze a portion of the fresh lung-mass, and there arises a sensation called *crepitation*; throw a bit into water, and it is seen to float; hold a bit under water, squeeze it, and bubbles will be seen to arise,—the *residual air* of the lung.

CHAPTER XXVI.

PHYSIOLOGY OF RESPIRATION.

326. The Respiratory Apparatus is designed to introduce *oxygen gas* (a food) into the system and to pass out *carbonic acid gas* and *vapor of water* (wastes). A little oxygen is taken in with common foods and through the skin. Some carbonic acid is passed out by the way of the skin, kidneys, and bowels.

327. The Common Pure Air about us is made up of about twenty-one volumes of oxygen and seventy-nine of nitrogen, well mixed. The latter acts to dilute the oxygen. The air also contains traces of dust, germs, carbonic acid, and moisture.

Illustrations.—A lighted candle placed in pure air burns well; in oxygen it burns brilliantly; in nitrogen it goes out. A rat placed in a jar of air lives well; in one of

oxygen he breathes very rapidly; in a jar of nitrogen he soon dies, for he can get no oxygen.

RESPIRATION.

328. *Breathing occurs in an adult about seventeen times a minute.* In breathing, air is drawn into the air-passages, and changed air is expelled from them. A respiration (one act of breathing) is made up of two actions: *in-spi-ra'tion* and *ex-pi-ra'tion.*

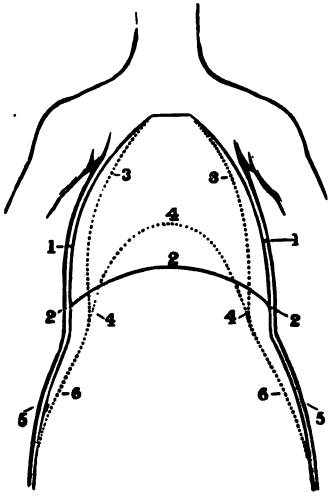

FIG. 41. A FRONT VIEW OF THE CHEST AND ABDOMEN IN RESPIRATION.—1, 1, The position of the walls of the chest in inspiration. 2, 2, 2, The position of the diaphragm in inspiration. 3, 3, The position of the walls of the chest in expiration. 4, 4, 4, The position of the diaphragm in expiration. 5, 5, The position of the walls of the abdomen in inspiration. 6, 6, The position of the walls of the abdomen in expiration.

329. Inspiration.—When the diaphragm contracts and flattens (Fig. 41, ^{2,2,2}), and the ends of the ribs are elevated and carried out by the contraction of the muscles between the ribs, the cavity of the chest is enlarged. (Fig. 41, ^{1,1}.) The lungs follow the variations in the capacity of the chest. Hence the air rushes into the nostrils (or mouth) and through the air-passages (313) to the lungs. This is inspiration.

330. Expiration.—When the chest-muscles cease contracting, the ends of the ribs descend; when the dia-

phragm ceases contracting, the contents of the abdomen arch the diaphragm up into the chest. (Fig. 41, ^{4,4,4}.) These movements lessen the capacity of the chest (Fig. 41, ^{3,4,3}), hence the lungs are compressed and a portion of the air in the air-passages is forced out. This constitutes expiration (*a*).

331. *The movements of respiration occur regularly.* By an act of the will we can increase their frequency; also we can hinder them; but we cannot stop them. These rhythmic movements are regulated by nerve-cells in the medulla (416).

THE CHANGES EFFECTED.

332. **The Inspired Pure Air** is rich in oxygen. In the air-passages it mixes with the air remaining therein. It becomes poorer in quality.

333. **The Expired Air** is less rich in oxygen and warmer than the inspired air. Furthermore, it is laden with carbonic acid, vapor of water, and bad-smelling compounds. By breathing, the air in the air-cells is changed,—oxygen enters and wastes pass out (*b*).

334. **Venous Blood.**—The blood which is forced from the right ventricle to the lungs is dark in color, owing to a deficiency of oxygen in the red corpuscles. It is laden with carbonic acid and wastes received in all parts of its circulation. (Fig. 24.)

335. *Interchanges occur in the capillaries of the air-cells.* The carbonic acid in the plasma of the blood passes through the thin walls of the capillaries and of the air-cells into the air-cells; the oxygen passes through the thin

walls of the air-cell, and of the capillary and the plasma of the blood (*c*), and enters the red corpuscle. (Fig. 42.)

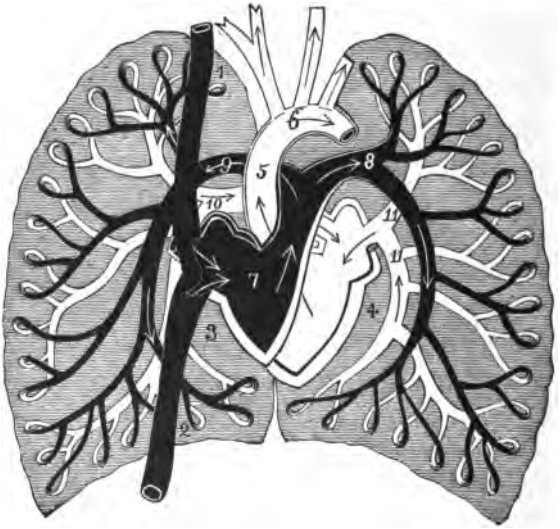

FIG. 42. PULMONIC CIRCULATION (a Diagram).—1, Descending vena cava. 2, Ascending vena cava. 3, 4, Lung. 5, 6, Aorta. 7, Right heart. 8, 9, Pulmonary arterial branches. 10, 11, 11, Pulmonary venous branches. The arrows show the direction of the current, the loops the capillary net-work.

336. Arterial Blood.—The blood which flows from the lungs to the left auricle (162) is of a bright scarlet color. Its red corpuscles are better supplied with oxygen than were those of the venous blood. Its plasma is less laden with carbonic acid than the venous blood.

337. Summary.—The function of the *air-passages* (313) is to warm and moisten the entering air on its way to the delicate air-cells; that of the *diaphragm and other muscles*

is to expand and contract the chest, as the arms and hands open and shut bellows in order to make a current of air; and that of the *lungs* to permit an interchange, allowing carbonic acid to pass from, and oxygen to pass to, the blood.

ACTION OF INJURIOUS AGENTS.

338. Alcohol, constantly circulating in the blood, has been shown to hinder the casting out of carbonic acid. It has been affirmed that it masses the corpuscles together, so that the oxygen cannot so readily reach them.

339. The Active Parts of Tobacco-Smoke, when drawn deep into the air-passages, rapidly enter the blood, and, later, work injury in all parts of the growing body. The hot smoke, alternating with colder air, causes the mucous membranes to become in turn over-full and under-full of blood; hence congestions and catarrhs (ka-tars′) of the air-passages are induced.

340. *Cigarette-smoking is the most injurious form of smoking.* (1) The entering smoke is hotter. (2) More of the nicotin and other bad agents enter the blood. (3) Quite frequently the cheaper cigarettes are made of waste tobacco and cigar-stumps; hence they are more deeply laden with the active parts.

341. Opium-Smoking differs from tobacco-smoking in that the opium is not burnt. The opium is heated in such a manner that the active parts of the opium exist in the steam from the drug. The inhalation of the steam produces the dreamy satisfaction of the "opium-smoker."

Observation.—Opium-smoking is not so great a source of

danger in our country as the uncalled-for use of "Soothing Syrups," cough-mixtures," and the morphia syringe.

(*a*) **FOR THE TEACHER. Directions for Demonstrations.**—Let a healthy boy remove the apparel covering his neck and chest, except a close-fitting undershirt. Have him stand easily erect and execute four or six full respirations in a deliberate manner, the class, meanwhile, watching the movements. In *inspiration* the chest and abdomen enlarge and the ends of the ribs are elevated. In *expiration* the abdomen sinks in, the ribs fall, and the chest becomes smaller.

Place a tape snugly around the chest, about three inches below the armpits. Notice the difference in circumference during a full inspiration and a complete expiration,—1st, in normal breathing; 2d, in labored breathing. Notice that the right half-circle of the chest is usually larger.

Place the forefinger flat on the wall of the chest. Tap this finger smartly with the first two fingers of the other hand. Test different parts of the chest in front and in the rear in the same manner. A clear sound denotes the presence of air in the organs beneath; a dull sound the presence of solids or liquids. The healthy lung-areas give forth a clear sound. By this method the limits of the lungs, the heart, the liver, and the intestines may be approximately mapped out.

Place the ear on the skin over the region of the trachea in front; a blowing sound is heard both in inspiration and in expiration. Then place the ear on the shirt, over the lung-areas, pressing the latter smoothly and closely on the chest-walls. Listen in one place during several respirations. Shift the ear to different parts of the chest and listen. A soft, low, murmuring sound is heard, being most marked over the front and upper parts of the chest and during inspiration. The murmur is mainly caused by the air passing in and out of the air-sacs and air-cells.

(*b*) **Experiments.**—Take a clean glass (fruit) jar with cover; fasten a piece of candle, with wire or a small nail, near the end of a stick twenty inches long. Lower the lighted candle into the jar; it will burn freely. Reverse the jar; shake after the taper is withdrawn. Now let some person take a full inspiration, retaining the air, for a time, in the lungs; then steadily expel it from the lungs into the jar, directing the current to one side; cover; soon breathe again in the same manner into the glass vessel, and lower a lighted candle. The flame will be extinguished, because the carbonic acid, the watery vapor, and other gases from the lungs have so vitiated the air in the jar as to prevent combustion. Such air will not sustain life. (Before entering deep wells or caverns, a lighted taper should be lowered.)

Place a little fresh lime-water in a jar, breathe several times into it, cover, and shake the lime-water. Instead of a clear liquid, there will be formed the white carbonate of lime.

Put a live rat in a jar. Regulate the supply of air by the cover, allowing first a liberal supply, then a limited supply, finally excluding the air entirely, and notice the results.

Breathe on the cool surface of a clean mirror, and *watery vapor* will be condensed from the saturated exhaled air. Take a clean, cool mirror into the recitation-room. In a few minutes examine the moist surface. If onions or leeks have been recently eaten, ether or chloroform inhaled, or alcoholics recently drunk, or if persons have decayed teeth, the expired air will give forth odors easily detected.

With a physician's thermometer test the temperature of the inhaled and exhaled air. In fever the expired air is much hotter than that of health.

(*c*) *Experiment.*—To show that gases may be interchanged through membranes, fill a bladder with dark blood drawn from any animal. Tie the bladder closely, and suspend it in the air. In a few hours the blood next the membrane will have become of a bright red color.

CHAPTER XXVII.

HYGIENE OF THE RESPIRATORY APPARATUS.

342. *In order that each tissue and organ shall be able to perform its functions properly*, the blood must convey to them a sufficient supply of oxygen; that the blood may receive its due amount of oxygen, the lungs and air-passages must be in good condition, and not impeded in their action; and that the gases entering the system shall not do injury, the air offered the lungs must be *pure.*

343. *The quality or purity of the air is affected by every respiration.* By breathing the quantity of oxygen is diminished, and that of carbonic acid is increased. Thus, every time we force air from the lungs it becomes unfit to be breathed again.

344. *Impurity of breathing-air is the most fertile cause of death among those commonly in action.* The effects of breathing an impure air do not usually appear suddenly. The continued use of a bad air undermines the health, increases the number of sick days per year, and ren-

ders diseases of parts other than the respiratory more severe.

Observation.—"The main exciting cause of drunkenness is, I believe, bad air and bad lodging." (*Charles Kingsley.*)

345. *Air in which lamps will not burn with brilliancy and which smells bad to an entering person is unfitted for respiration.* In crowded rooms, which are not ventilated, the air is vitiated, not only by a decrease of oxygen and an increase of carbonic acid, but by the waste, injurious materials thrown out from the lungs and skin of the audience (*a*).

Observation.—The common factor in the causation of destructive lung-disease (consumption) in all climates has been found to be the breathing of air made impure by respiration.

346. *While occupying a room we are insensible to the gradual vitiation of the air.* This is the result of the diminished sensibility of the nervous system and gradual adaptation of the organs to blood of a less stimulating character.

347. *Bernard's experiment.* A sparrow was placed in a glass globe. This was sealed. At the end of the first hour it showed evident signs of suffering. At the end of the second hour a second sparrow was placed in the globe. It seemed stunned, and died in a few minutes. At the end of the third hour the first bird appeared as dead. It was taken out and placed in sunshine in the open air, where it revived. When again placed in the globe it tottered, fell over, and died. *The process of death in badly-ventilated rooms is gradual.*

348. *Churches, concert-halls, and school-rooms should be well ventilated.* If they are not, the persons assembled in them will be restless and complain of languor and perhaps headache. In all school-rooms it is advisable to have a recess of five or ten minutes each hour. During this time let the pupils breathe fresh air, and open the doors and windows, so that the air of the room shall be completely changed (*b*).

349. *Breathe through the nostrils.* The hairs at the entrance act as a sieve. The long, tortuous air-passages are lined with a membrane the blood-vessels of which are laden with warm blood, and the surface of which is bathed with moisture. Hence the cool entering air, upon reaching the smaller tubes, is moist and warm. Avoid a tainted air.

Observation.—Indians are remarkably free from affections of the nose, throat, and ears. The immunity is largely due to their habitual practice of nose-breathing. (*Wagner.*)

350. *Mouth-breathing is noisy, gives rise to bad odors, and is unhealthy.* Mouth-breathing in cold weather introduces cold air too quickly to the fine air-tubes, and often induces catarrhs, and even lung-fever.

351. *In order to guard against diseases whose germs are carried in the air* (malaria, cholera, scarlet fever, diphtheria, etc.) you must be clean,—clean in your person, in your clothing, in your room, in your house and about your house. Keep the windows shut, and you keep in the germs; open them, and they pass out with the changing

air. A clean, dry air is unfavorable for the activity of germs and for their increase.

352. *In very malarious districts only the upper floors ought to be occupied at night.* You must breathe night air: there is no other. Hence have your rooms well ventilated, especially at night. Flannel should be worn next to the skin. Hot coffee and a good breakfast help to ward off the malarial agent. *Spirits are useless.*

353. *The size of the chest and lungs can be diminished by moderate and continued pressure.* This is most easily done in infancy, when the cartilages and ribs are very pliant; yet it can be effected at more advanced periods of life. (Fig. 44.)

Observations.—(1) The Chinese, by compressing the feet of female children, prevent their growth; so that the foot of a *Chinese belle* is not larger than the foot of an American girl of five years. (2) The American women *compress their chests* to prevent their growth; so that the chest of an *American belle* is not larger than the chest of a Chinese girl of five years. Which country, in this respect, exhibits the greater intelligence?

354. *When the lungs are properly filled with air, the chest is enlarged in every direction.* If any article of apparel (corsets, vests) is worn so tight as to prevent the full expansion of the chest and abdomen, the lungs, in consequence, do not receive air sufficient to purify the blood. The penalty for thus violating a law of our being is disease and suffering.

Observation.—Scholars and persons who sit much of the

time should frequently during the day stand erect, loosen the garments, and breathe full and deep, so that the smallest air-cells may be fully filled with air. While exercising the lungs the shoulders should be thrown back and the head held erect.

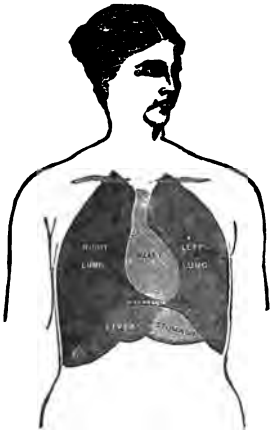

FIG. 43. AN OUTLINE OF A HEALTHY FEMALE.

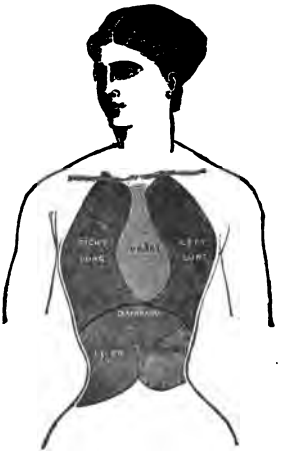

FIG. 44. AN OUTLINE OF A WELL-CORSETED MODERN BEAUTY.

ACTION OF INJURIOUS AGENTS.

355. *The custom of taking alcoholics to "keep out a cold" is not physiologic.* It is better to use hot tea, hot spice tea, or hot Cayenne tea, than to use alcoholics.

356. *Alcohol and consumption.*—The common belief that alcohol has the power of preventing consumption of the lungs is not sustained in practice, for many constant users of alcoholics die of consumption (*c*).

357. *That tobacco-smoking is injurious to the young is now unquestioned.* Tobacco-smoke occasions catarrh (ka-tar′) of the throat and of the larynx, and, by extension to the middle ear, a tobacco-throat catarrh may induce difficulty of hearing. A kind of sore throat called "smoker's sore throat" is not an uncommon malady among smokers.

358. *The evil effects of opium-smoking* have been thus summed up by a Chinese mandarin: "Loss of appetite, loss of strength, loss of money, loss of time, loss of longevity, and loss of virtue, leading to profligacy and gambling" (441).

(*a*) **The Black Hole of Calcutta** received its name from the fact that one hundred and forty-six Englishmen were shut up in a room eighteen feet square, with only two small windows on the same side to admit air. On opening this dungeon, ten hours after their imprisonment, only twenty-three were alive. The others had died from breathing impure air that contained animal matter from their own bodies as well as carbonic acid.

(*b*) **School-Room Defects.**—According to Cohn, the school-room windows collectively should equal at least one-fifth of the floor-space; some American authorities allow only one-sixth. Most school-rooms in the United States have the following faults: (1) the cubic space allowed to each scholar is too small (minimum space should be two hundred and fifty cubic feet to each scholar); (2) the means of ventilation are, as a rule, wholly inadequate, even if the cubic space allowed were sufficient (minimum of fresh air should be fifteen hundred cubic feet per hour per pupil); and (3) the desks are not placed to admit the best action of the eyes.

(*c*) **Alcohol and Phthisis.**—"The belief that alcohol has the power of arresting phthisical (consumptive) development is one which experience does not sustain. . . . If an individual with developed phthisis reaches complete recovery while taking alcoholic stimulants freely, I am confident that he would have reached it more rapidly and safely without them. . . . Malt liquors and wines do less harm (in consumption) than whiskey and brandy." (*A. L. Loomis, M.D.*, 1885.)

BLACKBOARD ANALYTIC SUMMARY OF THE RESPIRATORY APPARATUS.

(Chapters XXV.–XXVII.)

- **ANATOMY OF . .**
  - *Air-Passages.*
    - Nasal Passages.
    - Pharynx.
    - Larynx.
    - Trachea.
    - Bronchiæ.
    - Air-Cells.
  - *Lungs.*
    - Air-Cells.
    - Connective Tissue.
    - Blood-vessels.
    - Nerves, Lymphatics, etc.
  - *Muscles.*
    - Diaphragm.
    - Intercostals, etc.
- **PHYSIOLOGY OF .**
  - *Respiration.*
    - Inspiration.
    - Gas-interchanges.
    - Expiration.
  - *Changes Effected.*
    - REMOVED.
      - Carbonic acid.
      - Vapor of water.
      - Odorous impurities.
    - INTRODUCED. Oxygen (a food).
- **HYGIENE OF . . .**
  - Pure air (unlimited amount).
  - Free chest and abdominal movements.
  - Nasal breathing.
  - Rapid removal of bad airs.
    - Sewer gas.
    - Once-breathed air
    - Germ-laden air.
  - Absence of dampness.
- **AVOIDABLE CAUSES OF ILL HEALTH.**
  - Alcoholic hindering of gas-interchanges.
  - Alcoholic structural changes.
  - Tobacco-smoke and Tobacco-snuff irritation.
  - Opium-smoking debility.

CHAPTER XXVIII.

THE HOME.

359. The Home, from a hygienic point of view, is a most important subject. The mother, the youngest children, and the elderly spend most of their hours beneath its roof. The young, the workers, and the middle-aged spend from one-third to one-half of their hours in its sitting- or sleeping-rooms (*a*).

360. *Gravel hillocks are the healthiest of all positions.* Pure sands and gravels are healthy. Clay, marl, and alluvial soils (fine clay and sand) must be considered as suspicious.

361. *Dampness is often as much of an enemy as filth.* In all cases it is best that the site be pipe-drained. Grass conduces to health. It removes water from the surface-soil, cools the air, prevents dust-gusts, utilizes the organic waste, and offers an agreeable hue to the eye.

362. *All soils contain a varying amount of moisture and damp air laden with the products of decay-processes.* The moist ground-air is quite liable to enter the cellar and ascend to the rooms above, inducing rheumatism and consumption (345). Thus it is that *illuminating gas* and *sewer-gas* from the street mains, and *gases* from rotting "made soils" and excreta in the soils, enter the home and cause ill health and disease.

363. *The windows should reach almost to the ceiling.* They should be so arranged as to be easily lowered. A single window may light a room, but such a room must have an open transom over the hall door to insure good air throughout the room. Every room should be so placed that direct sunlight shall enter for a few hours daily (*b*).

Observations.—Houses where the long axis runs east and west cannot well fulfil this requisite. The dark inner rooms of the houses occupied by artisans, clerks, and laborers are fertile sources of ill health, misery, and crime. Beware of a house having a "musty-smelling" hall.

364. *Sunlight keeps the air in motion.* It brings to notice collections of dirt and filth in the corners and under furniture. It works against the growth of moulds and low organisms. *Tent-life*, insuring abundance of pure air and sunlight, is excellent for summers.

365. *Irregular, rapid, and excessive currents of air are injurious.* The inlet-tubes must be short, smooth, and easy of access for cleaning purposes. Each room ought to have its own inlets. If the incoming air is not warmed, inlets should discharge about four feet from the floor.

366. *In ordinary houses the outlets must be near the ceiling.* In most house-rooms, the lowering of the windows will suffice. It is better, however, to provide ample outlets near the ceiling. These outlets should have no valves. A grating over the chandelier should always be present.

367. *Rooms warmed by stoves may be fairly ventilated* by putting a board about four inches wide, extending

from side to side, under the lower sash of each window, and having one sash lowered at the top, or by using double windows, having the outer lower and the inner upper constantly open.

368. *The open fire is a healthy method of warming a small room in a moderately cold climate.* The heat is pure heat, not the drying, parching, impure air warmth of the stove, furnace, or steam-pipe. Persons who have an open fire, as a rule, suffer less from coughs, colds, headaches, neuralgias, and petty ills than do those who keep their rooms close, stuffy, and hot with stove- and furnace-heat (*c*).

369. *Every house ought to have a good thermometer.* The right temperature of rooms in winter is important. The temperature should be taken about four feet from the floor, on the side of the room opposite to the heater. At this place the temperature may be kept at 60° F. in rooms for the healthy.

370. *Plants in the living-rooms are air-purifiers during the hours of sunlight.* They do little or no harm in the sleeping-room during the night-hours, if the room is well ventilated.

371. *Sleeping-rooms, in which one-third of life is passed, should be located so as to receive the direct sunlight several hours daily.* If there is no fireplace in the room in which a fire is kept for a few hours daily, or a lighted taper burning all night, then the upper sash must be kept lowered night and day (*d*).

372. *The influence of "sewer-gas" is most marked on children,* especially when the gas enters the sleeping-room.

The children become pale, and are languid in their movements. They lose their appetite. They suffer quite frequently from diarrhœa and blood-poisoning.

373. "*Mould and decaying vegetables in a cellar weave shrouds for the upper chambers.*" A damp cellar is a very undesirable feature of a home. Cellars ought to have many windows, in order to admit the sunlight, and to provide for cross-ventilation.

374. **Healthy Homes.**—The objects to be secured in a healthy home are perfect purity and cleanliness of the air; freedom from excessive moisture; ample direct sunlight in every room; an abundance of pure water (204 *a*); a ready removal of solid, liquid, and gaseous waste-substances; and the minimum of stair-climbing (*e*).

(*a*) **The more Common Diseases among Farmers are**: (1) Air-passage maladies in various forms. (2) Rheumatism. (3) Dyspepsia. (4) Fevers, especially of a typhoid type. The farmer's home is too often located in a low, damp, and unhealthy spot. In such cases the cellars are damp and the drainage poor. In order to save steps the house-well is quite near the barn, perhaps the barn-yard, the sink-drain, and the water-closet, as well as the kitchen. Farm-houses are no oftener badly located than houses in villages, towns, and cities, but in the latter there is little or no choice. Farm-houses may be and ought to be better located than city residences.

(*b*) **Air-Space.**—To secure and continue the best health attainable, there should be one thousand cubic feet of space allowed per head in buildings permanently occupied as dwelling-houses. In sick-rooms there should be twelve hundred to two thousand cubic feet of space per head. The air of a sick-room must be frequently renewed. The entering air for a room occupied many hours in succession should not be less than twenty-five hundred cubic feet per hour per head.

(*c*) **The Stove** is an economical but unhealthy heating agent. There should be no *back-damper*, because it prevents the rapid escape of the products of the burning. The *water-urn* should be so near the source of heat that large amounts of water-vapor may be given forth to mitigate the parching heat. The *close stove*, for wood or coal, heats the air of the room. It takes oxygen from the room-air to continue its burning. It directly brings no fresh air into the room. It takes little foul air out of the room. It does not ventilate. It gives forth a dry, parching, and, too often,

excessive heat. It furnishes to the room upwards of three-fourths of the heat evolved, while the open fire only affords one-eighth.

(*d*) "**Modern Improvements,**" as a rule, are a constant source of peril to health. "*Sewer-gas,*" which rapidly forms in unclean waste- and sewer-pipes and cesspools, defies all "traps." Hence the "soil-pipe" should extend above the roof, and the wash-basins of sleeping-rooms and closets should not be in connection with the sewers. "Any sanitary arrangement that is not used is dangerous." (*Corfield.*) *Gas-pipes,* for they may leak, ought never to be within the walls or under the floors of sleeping-rooms.

(*e*) **Unhealthy Homes.**—The failings of any house in respect of healthiness may be attributable to (1) improper site; (2) evil arrangement of the house consequent on faulty planning; (3) bad drainage, presence of cesspools, unsound plumbing, want of disconnection and ventilation of the drains; or (4) a poisonous water-supply. (*Rogers Field.*)

CHAPTER XXIX.

THE VOICE.

ANATOMY OF THE VOCAL ORGANS.

375. Seat of Voice.—Experiments on living animals and the study of the larynx in action show that the true vocal cords are the essential organs for the production of voice. The vocal cords are seated in the *lar'ynx.* (Fig. 46, *.)

376. The Larynx (Adam's apple) is a kind of cartilaginous box, which, taken as a whole, has the general form of a hollow reversed cone, open at both ends. The *cartilages,* which make up the frame-work of the larynx, are united by ligaments. (Fig. 45.)

377. The Vocal Cords (Fig. 46, * *) are folds of membrane, on the same level, found in the interior of the

larynx. (Fig. 31.) The space between the cords (*o*) is the chink of the *glot'tis*.

Observation.—The tones of the confirmed drinker are hoarse. This is due largely to a thickening and roughening of the contiguous edges of the vocal cords, induced by alcoholic irritation.

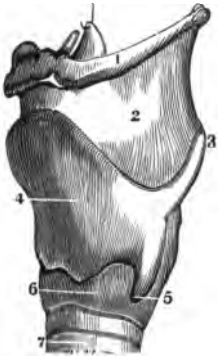

FIG. 45. SIDE VIEW OF THE CARTILAGES OF THE LARYNX.—1, Hyoid bone. 2, Membrane. 3, 4, Thyroid cartilage. 5, 6, Cricoid cartilage. 7, Trachea.

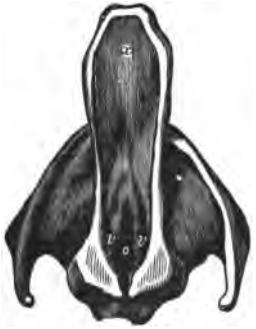

FIG. 46. THE VOCAL CORDS as seen when looked down upon by means of the laryngoscope. *o*, Chink of glottis. *v*, *v*, Vocal cords. *x*, Epiglottis, as in breathing.

378. Epiglottis.—Behind the base of the tongue is a piece of cartilage resembling a leaf of parsley, called the *ep-i-glot'tis*. (Fig. 31.) The duty of this sentinel is to keep the food and drink from passing into the air-passage (*a*).

PHYSIOLOGY OF THE VOCAL ORGANS.

379. The Cartilages give form and stability to the larynx, and by the action of muscles attached within them the width of the glottis is varied.

380. Sound Production.—When the muscles within the larynx contract, the vocal cords are made tense and the right and left cords are brought close together. If now air is forcibly driven from the lungs through this narrow chink, the vocal cords are caused to tremble or vibrate. These vibrations affect the air in the larynx, throat, mouth, and nose, and varied *sounds* result.

Observation.—The voice of the child is shrill because the vocal cords are short; a man's is deep, for the cords are long. At the time of the "breaking of the voice" there is a rapid growth of the larynx and a lengthening of the vocal ligaments, or cords.

381. *Speech, or the utterance of articulate sounds, is a distinctive characteristic of man.* Animals have voice; man alone has speech. The raven may be taught to speak by rote, but man alone attaches meaning to the word-sounds and phrase-sounds he employs.

382. *The true vowels, or open sounds, are generated in the larynx.* They are uninterrupted vocal tones, modified in the outward passage by alterations in the length and shape of pharynx, mouth, and lips. The *consonants* are entirely formed in the parts above the vocal cords. They are produced by the expiratory current of air being in various ways interrupted or modified in its course through the throat and mouth.

HYGIENE OF THE VOCAL ORGANS.

383. *The voice is strong in proportion to the development of the larynx and the capacity of the chest.* Singing and

reading aloud improve and strengthen the vocal organs, and give a healthy expansion to the chest.

384. *The attitude also affects the modulation of the voice.* Read with the head bowed forward and the chin depressed; then read with the head erect and the chin elevated, and the difference in the movement of the vocal organs, together with the difference in the voice, will be manifest.

385. *The muscles and veins of the neck should not be compressed.* If the muscles of the neck and the larynx are compressed by a high collar or other close dressing, not only will the free and forcible use of these parts be impeded, but the tones, instead of being clear and varied, will be feeble and ineffective.

Observations.—(1) The loss of voice which is prevalent among public speakers may be ascribed in part to the injudicious dressing of the neck, to speaking in too high a tone, and to improper position when standing. (2) Muffling the neck in scarfs, furs, and wraps is not a good plan. Except in very severe weather, the wearing of anything other than a light silk handkerchief increases the liability to catch cold.

386. *A large amount of air in the air-passages, and a control over that air, are essential to good vocalization (singing, recitation, reading).* Hence go out of doors into the fields or the park. If the thoracic and abdominal garments are "snug-fitting," loosen them. Slowly draw air in through the nasal passages. Fill the chest quite full. Do not strain. Allow the air to pass out slowly and deliberately.

Execute twenty or thirty of these movements. Repeat the series, if possible, several times daily.

387. *During vocal exercise an easy, erect posture should be maintained.* The chest, abdominal, and neck apparel must be loose-fitting. Tight lacing leads to improper breathing, and tends to give a tremolo and a bad quality to the voice. The exercises must not be carried to the point of exciting soreness or fatigue. They should be graduated and progressive. The course should not be hurried.

Observation.—During the transition period, from the thirteenth to the sixteenth year, the vocal organs should not be unduly exercised. In some children all vocal drill and practice should be suspended (380).

388. *The breathing of an air laden with tobacco-smoke is injurious to the voice.* The deep inhalation of hot tobacco-smoke is most pernicious. The use of strong tobacco is markedly injurious to the quality of the voice.

389. It is probably true that a majority of the celebrated vocalists use *alcoholics* in moderation. From replies received from nearly four hundred singers, Dr. Browne learned that about three-fourths expressed an opinion that alcohol did not aid the voice.

(*a*) **Directions for Dissection.**—Secure the root of the tongue, the larynx, and upper part of the trachea of an ox or hog. Note: that the *mucous membrane* of the tongue and throat is continuous with that of the larynx, which in turn is continuous with that of the trachea; that the *œsophagus* lies just behind the larynx; that when the vertical-standing *epiglottis* is pushed down, objects can pass into the œsophagus, but not into the larynx. Cut away the œsophagus and all stray bits of muscle and fibres.

Lay open the larynx by an incision on the œsophageal side, extending from

pharynx to trachea. The broad right and left cartilages, the *thyroid*, and the cut edges of the lower ring-like cartilage, the *cricoid*, are brought into view. In the interior, from above downward, note: the *mucus* on the surface, the two contiguous surfaces forming the upper *slit*, two right and left pits, the *ventricles* of the *larynx*, and two thin, contiguous surfaces, forming the *true vocal cords*, and the cut *cricoid*, with the two *arytenoid* cartilages resting thereon.

GENERAL REVIEW QUESTIONS.

Anatomy of the Respiratory Organs.

Name and locate the divisions of the air-passages. (312, 313.) Describe the thorax and diaphragm. (314, 315.) Describe the air-passages. (316–321.) Give the anatomy of the lungs and pleura. (323, 324.) How does alcohol alter the lung-tissues? (325.)

Physiology of Respiration.

What is the function of the respiratory apparatus? (326.) Give the composition and properties of common air. (327.) Describe the phenomena of respiration. (328–331.) What changes does respiration effect? (332, 333.) Compare venous with arterial blood. (334–336.) Give the respiratory summary. (337.) How does alcohol influence the respiratory process? (338.) Why is smoking injurious to the young? (339, 340.) Mention the American opium dangers. (341.)

Hygiene of Respiration.

What vitiates room-air? What may result? (343–346.) What is shown by Bernard's experiments? (347.) Mention important personal precautions. (349, 350.) What precautions should be taken against germ-diseases? (351, 352.) What is the effect of chest-constriction? (353, 354.) What is the influence of alcohol on chest-diseases? (355, 356.) Why is it advisable to cease tobacco- or opium-smoking? (357, 358.)

The House.

Mention conditions essential in the site. (360–362.) What is essential as regards light, space, and air? (363, 364.) How may good air be secured? (365–369.) What necessary precautions in

the sleeping-room? (371–373.) What is needed in a healthy home? (374.)

The Voice.

Describe the vocal apparatus. (376–378.) How are vocal sounds produced? (380.) What modifies the quality and intensity of sound? (381, 382.) Mention causes of throat- and voice-troubles. (383–385.) What is necessary in voice-culture? (386, 387.) How does tobacco affect vocalization? (388.)

BLACKBOARD ANALYTIC SUMMARY.

(Chapter XXIX.)

- THE ORGAN OF VOICE.
  - ANATOMY OF . .
    - *Larynx.*
      - Mucous Membrane.
      - Cartilages.
      - Vocal Cords.
      - Muscles.
    - *Upper Air-Passages.*
      - Nasal Passages
      - Pharynx.
      - Mouth.
        - Teeth.
        - Tongue.
        - Lips.
  - PHYSIOLOGY OF
    - Vowel-sound production.
    - Consonant-sound production.
  - HYGIENE OF .
    - Nasal breathing.
    - Free chest and abdominal movements.
    - Control over the breathing.
    - Easy, erect posture.
    - Methodical graduated drill.
    - Avoidance of strong tobacco.

CHAPTER XXX.

THE NERVOUS SYSTEM.

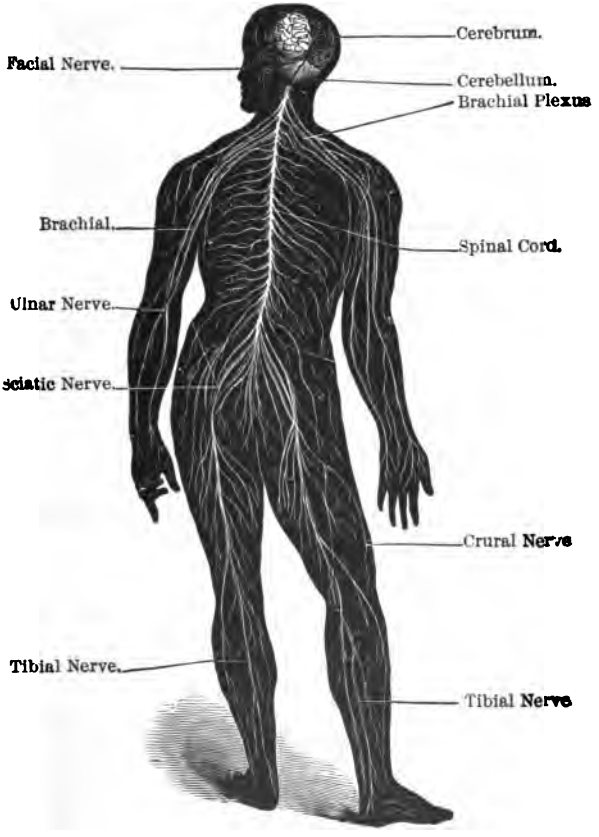

FIG. 47. DIAGRAM OF BRAIN, SPINAL CORD, AND SPINAL NERVES.

GENERAL SUMMARY.

390. In the preceding chapters the structure and use of the bones, muscles, and skin have been explained; the nature of foods and beverages has been touched upon; the organs of secretion and their activities have been described; and the processes by which foods and beverages are fitted to enter the blood have been detailed.

The course which the prepared food takes to enter the blood, the picking up of the waste and useful particles in the tissues and their reconveyance to the blood, and the introduction of oxygen and the casting out of wastes, have been set forth. The organs by which the blood is distributed to all the parts, organs, and tissues have also been considered.

391. These functions must often occur at the same time, and always, in health, must succeed each other in the proper order. The mutual dependence of these processes is such that there must be regulating and controlling centres, as well as media of communication from part to part. This is effected by means of the *nervous system.*

ANATOMY OF THE NERVOUS SYSTEM.

392. The Nervous System is composed of the *Brain*, the *Spi'nal Cord*, the *Gan-gli-on'ic System*, and the *Nerves.*

393. The Brain is a pulpy mass found in the cavity of the skull. (Fig. 47.) The upper and front and larger portion is called the *cer'e-brum;* the lower and smaller portion, the *cer-e-bel'lum.* (Fig. 48.)

394. The Cerebrum (ser'e-brum) is composed of a

white central mass, covered by a thin layer of gray material arranged in folds (Fig. 48), called *con-vo-lu'tions.*

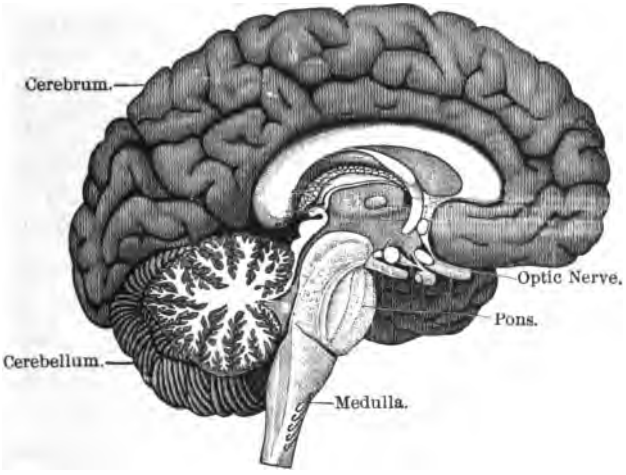

FIG. 48. LEFT HALF OF BRAIN, as seen from the inner side.

Observation.—In man, the cerebrum is so large that it overlaps and conceals the cerebellum. This is not seen in other healthy adult animals.

395. The Cerebellum (ser-e-bel'lum) is also composed of white and gray nerve-matter. The white matter is so arranged that, when cut vertically, the appearance of the trunk and branches of a tree (*ar'bor-vi'tæ*) is presented. (Fig. 48.)

396. The Pons is the bridge of nerve-fibres connecting the cerebrum, cerebellum, and spinal cord. (Fig. 48.)

397. The Spinal Cord is a tail-like extension of nerve-matter from the base of the brain as far as the second

lumbar vertebra. (Fig. 47.) It lies in the *spinal canal*.

FIG. 49. SECTION OF SKULL AND VERTEBRAL COLUMN.—1, Cerebrum. 2, Cerebellum. 3, Medulla. 4, Spinal Cord, lying in the Spinal Canal.

FIG. 50. A SECTION OF THE BODY, SHOWING THE GANGLIONIC MASSES AND THEIR CONNECTING NERVES.—A, Ganglia of abdomen; C, of heart; D, D, of thorax; Q, of neck; Y, of the face; 5, of the pelvis.

(Fig. 49.) It is made up of two halves of white matter, having a core of gray matter.

398. The Medulla is the portion of the cord lying within the skull. It contains important masses of gray matter. (Fig. 48.)

399. Membranes.—The brain and cord are surrounded and protected by three membranes. The outer one (*dura mater*) lines the spinal canal (15) and skull. (Fig. 31, ^{e}.)

400. The Ganglionic System (Sym-pa-thet'ic of some authors) consists of a chain of nerve-masses (one on each side of the spinal column) extending from the base of the brain to the pelvis. (Fig. 50.) The nerve-masses (*gan'glia*) are connected with each other and with the brain, or spinal cord, by nerves.

401. The Nerves are small white cords made up of many nerve-fibres. Each nerve-fibre is isolated from the adjacent nerve-fibre. (Fig. 47.) The nerve, like the telegraph-cable, has conducting central parts and protective outer parts.

402. The Cranial Nerves originate in the brain, pass out through holes in the skull, and, for the most part, end in organs of the face and chest (eyes, ear, nose, heart, lungs, larynx, etc.) and muscles of the face. They number twelve pairs. (Figs. 47, 55, ^{1,2}, 56, ^{5}, 57, ^{11}.)

403. The Spinal Nerves start from the spinal cord, pass out through openings between the vertebræ, and, for the most part, end in the muscles and skin. There are thirty-one pairs. (Fig. 47.)

404. The Ganglionic Nerves come from the ganglia, and are distributed to the organs of the chest and abdomen (Fig. 50) and to the muscles of the arteries (153).

STRUCTURE OF THE NERVOUS SYSTEM.

405. The Nervous System is composed of two special structures: the *nerve-cell and* the *nerve-fibre.* (Fig. 51.)

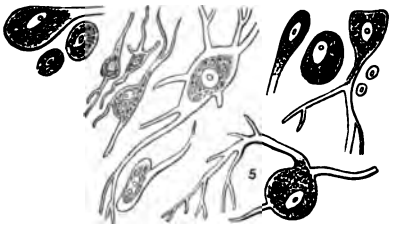

FIG. 51. NERVE-CELLS WITH COMMENCING FIBRES. (Magnified one hundred diameters.)

406. The *gray matter of* the *ganglia, the spinal cord,* and *the brain - convolutions* is made up of nerve-cells, held in place by webs of delicate connective tissue.

407. The Nerves are made up of white nerve-fibres, held in place and surrounded by delicate connective tissue. The *white portions* of the brain and cord are similarly constructed.

ALCOHOLIC STRUCTURAL CHANGES.

408. Alcohol has been found in the fluid of the brain of old topers. In the majority of such cases the brain and cord are found to be shrunken and hardened. A *microscopic examination* usually shows that many of the nerve-cells are fatty, and that the connective tissue (406) is increased in quantity. *The nerves,* however, do not show such distinct and marked evidences of change as do the nerve-cell masses.

409. Of the structural changes produced by the *constant use of tobacco and opium* on the nervous tissues little or nothing is at present known.

(*a*) FOR THE TEACHER. **Directions for Dissection.**—Remove the skin from the head and neck of the animal, as of a dog, rat, or rabbit. Cut out and remove the lower jaw and its appendages. If possible, allow the parts to become thoroughly frozen. With a cold saw, in the median line saw vertically between the nostrils, through the bones of the face, of the skull, and vertebræ as far as the fifth or sixth cervical vertebra, as in Fig. 52. At this part saw in at right angles, and remove one-half. Remove all splinters, loose tissue, etc.

The parts thus brought into view are the *scalp*, or the movable, hairy portions over the vertex; the *periosteum* of the cranial bones; the *cranial bones*, exhibiting in places two layers of compact bone, with an intermediate cancellated layer; lining the interior of the cranial vault, a hard, firm, resisting membrane, the *dura mater*, which dips down from the vertex near the median line, forming a divisional fold between the right and left brain, the *falx*. Beneath the free edge of the falx is seen the cut surface of a band of white nerve-matter connecting the right with the left brain, the *corpus callosum*. Beneath the corpus callosum will be seen a right and a left depression, the *lateral ventricles*.

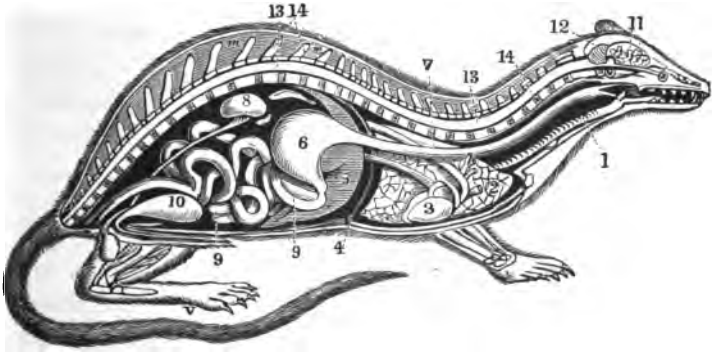

FIG. 52. SECTION OF A SMALL MAMMAL.—1, Trachea. 2, Lungs. 3, Heart. 4, Diaphragm. 5, Liver. 6, Stomach. 7, Œsophagus. 8, Kidney. 9, 9, Intestines. 10, Bladder. 11, Cerebrum. 12, Cerebellum. 13, 13, Spinal cord. 14, 14, Vertebræ in section.

With the handle of the scalpel loosen the cranial contents of one side from its case. Turn it out gradually, severing, as they present, the *nerves* leading to the nose, eye, etc., near the base, the posterior cranial and the spinal nerves. The larger mass, the *cerebrum*, is somewhat triangular, and presents on its gray surface a number of *convolutions*, and beneath a number of white, projecting fibres, the *cranial nerves*. Behind the larger brain, separated from it by a deep depression, is a smaller mass, the *cerebellum*, whose cut surface presents a tree-like appearance of white in gray.

Its outer surface is gray, like that of the cerebrum, but is arranged in more or less parallel ridges. Connecting the cerebrum and cerebellum and the medulla is a mass of nerve-substance, the *pons*, or "bridge." Leading back from this is the *spinal cord*, the enlargement of which, near the cerebellum and lying within the skull, is called the *medulla oblongata*. Leading from the inferior aspect of the cerebrum, pons, and medulla are seen numerous fibres, the *cranial nerves*, and from the cord a pair of nerves for each intervertebral space, the *spinal nerves*.

The outer surface of the brain is smooth and moist. Dipping down into all the sulci will be seen a web-like membrane, abundantly provided with blood-vessels, the *pia mater*. The smooth, firm membrane lying in the cranium is the *dura mater*.

In the frozen brain make a vertical incision with a sharp, thin-bladed knife parallel to the median surface, about half an inch from the falx border. This section shows that the convolutions and ridges are made up of gray nerve-matter, in the form of a much-puckered layer; that the bulk of the cerebrum and cerebellum is composed of white matter; that at the base of the brain are a number of gray *ganglionic* masses; that the *pons* is in connection with the cerebrum, cerebellum, and, through the medulla, with the cord; that in the *medulla* there are gray masses; and that the *cord* has a gray central and a white outer layer. If a cross-section of the cord is made, a gray centre, with projecting horns, and an upper and lower groove in the white matter, is presented. On the anterior under side of the cerebrum is seen projecting forward a small, elongated, globular mass, the *olfactory lobe* of that side. Just back of it are seen two round, white cords, commencing to cross each other, the *optic tracts*.

The *skull* is seen to be arched above, the under side of the arch having a uniform surface; below it presents depressions, projections, and numerous openings. The large opening on the posterior part of the skull affords passage for the cord and blood-vessels, and is called the *occipital foramen*. The other openings serve for the entrance of arteries and outlets for the cranial nerves and the veins.

Remove the skin from the neck and thorax and from the fore-limb of the opposite side from which half the skull was removed. Place the animal on its back. Cut the *pectoral muscles* (the muscles which hold the limb to the trunk) close to their insertion in the humerus, and allow the limb to fall from the trunk. Remove the loose connective tissue between the limb and the neck-back region, and the many white cords of the *brachial nerve plexus* will be exposed. Trace the *nerves* to the intervertebral places of exit. By the removal of the connective tissue, the dissecting out of some and the cutting of other muscles, the nerve and the neighboring arteries can be traced in their distribution down the limb. Observe that the nerve-trunks are placed on the inner side of the limb, that they lie between muscles, and are deeply embedded in areolar tissue, and that they are distributed to all tissues of the limbs, including the membranes of the joints.

CHAPTER XXXI.

PHYSIOLOGY OF THE NERVOUS SYSTEM.

410. The Brain *is the organ of the mind.* In the absence of the brain,—yes, in the absence of certain portions of the con-vo-lu'tions of the cerebrum, no *will*, no *intelligence*, no *speech*, is exhibited.

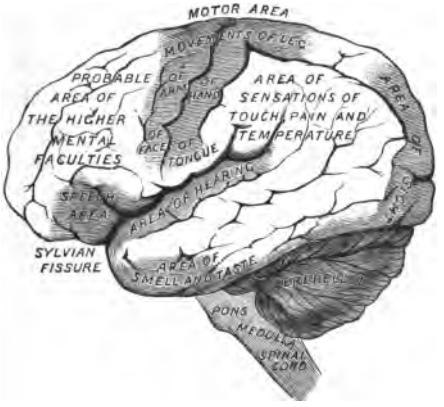

FIG. 53. LOCALIZATION OF FUNCTION IN THE BRAIN. (*Designed by A. L. Ranney, M.D.*, 1885.)

411. Will.—The animal whose large brain has been removed may live, eat, grow, move, and secrete, yet he will pay no attention to external objects or sounds, and will not change his place of his own accord. *The will is manifested through changes occurring in the cerebrum.*

412. Intelligence.—If certain parts of the convolutions

of the large brain are removed the animal becomes unable to see; if certain other parts, he is unable to hear; if certain other portions, he is unable to feel in definite parts; if certain other parts, he is unable to make movements of definite parts. (Fig. 53.) *The higher mental faculties (reason, memory, self-control, judgment, thought) require the concerted action of different parts of the cerebral surface.*

413. Speech.—In a number of cases where persons had lost the ability to express their thoughts by speech, definite portions of the large brain were found to be structurally altered. *The "centres" for speech are in the cerebrum.*

414. Effect of Injuries.—The brain-substance is not sensitive. It may be cut or pricked without exciting pain. Considerable portions of the white and the gray matter have been removed with comparatively little bad effect on the mental activities (*a*).

415. The Cerebellum supervises and regulates most voluntary muscular actions. When it is diseased most movements become disordered. The *pons* is largely a path of communication.

416. The Gray Masses of the Medulla exercise a control over the functions essential to life. They regulate heart-action, lung-action, gland-secretion, swallowing, etc. If the medulla is destroyed, death results at once.

417. The Spinal Cord is a great path of communication between the muscles and skin and the brain. If it is broken or cut, say in the back, the power of voluntary motion as well as sensation is lost in the limbs (*paraplegia*).

418. *The spinal cord carries into effect the orders of the brain for well-learned movements*, as the movements of the skilled fingers in needle-work or piano-playing, or the movements of the trained limbs in walking, dancing, etc., for these movements may be executed while the thoughts are otherwise engaged.

Illustrations.—In learning to walk the child has to keep his eyes on his steps, otherwise he falls. The apprentice has to watch his fingers and his work, otherwise he injures the work, or perhaps himself.

419. *The spinal cord is the great seat of "reflex action."* Reflex actions are purposeful movements done without demanding the attention of the mind. Coughing, winking, and swallowing are reflex acts.

420. **The Ganglionic System** directly excites and controls the movements essential to secretion, digestion, blood circulation, heat regulation, etc.

421. **The Nerve-Fibres** of the nerves conduct signals or impulses. They work like the strands of the copper core of the telegraph-cable, which serve to conduct electricity.

Observation.—When a nerve is cut or severely pressed it cannot conduct impulses. Thus, when a person "sleeps on his arm," on awakening he finds the fingers numb and not sensitive to pricks. The pressure has interfered with the conduction-power of the nerve.

422. *In a physiological sense there are two kinds of nerve-fibres.* One kind of fibres conduct impulses to the brain, occasioning sensations, as pain (*sen'so-ry fibres*);

the other kind conduct impulses outwards to the muscles, exciting the latter to action (*mo'tor fibres*).

Illustrations.—The nerves of smell, sight, and hearing transmit sensory impulses alone; four of the cranial nerves are purely motor; and the other cranial and all the spinal nerves are mixed (sensory and motor).

423. The Nerve-Cells generate nerve-impulses (nerve-force). They receive impulses; they remember impulses. *Hence in groups of nerve-cells are generated the controlling forces of the living body.*

424. Summary.—All parts of the body are intimately connected as by a perfect telegraph system. Each part of the body has its own receiving and sending instrument (*nerve-cell masses*), its own wire (*nerve-fibres*), its own district office (*ganglia, spinal cord, medulla, cerebellum*), and its own "division" (*brain "centres"*), at the head-office (*cerebrum*). *The work of the living body is unified, regulated, and co-ordinated through the nervous system.*

(*a*) **Effect of Brain Injuries.**—In 1877, when house-surgeon at Boston City Hospital, I had under my charge a man suffering from compound comminuted fracture of the left vault. Eleven pieces of bone were removed, leaving a hole about one and a half inches in diameter. The man lived eighty-three days, retaining his mental faculties, speech, and motion up to the last week. After the primary inflammation had subsided the cerebral tumor was insensible to gentle manipulation. During waking hours it was gorged with blood and projected; during deep sleep it became pale, and partially sank into the cranial cavity.

A laborer in New Hampshire was tamping a charge of powder into a rock, when, by a premature discharge, the rod (three feet seven inches long, one and one-fourth inches in diameter) was driven into the left side of the face near the angle of the jaw, passed through the front part of the cranial cavity, and emerged through the frontal bone in the median line, driving bone and brain before it. The man recovered, although with loss of sight in the left eye. Later this man drove coach in Chili. Twelve years later he lost his life in California.

CHAPTER XXXII.

THE ACTION OF AGENTS INJURIOUS TO THE NERVOUS SYSTEM.

425. **Alcohol.**—A *small dose* (in a person not accustomed to its use) slows the rate of nerve-conduction, increases the number of heart-beats, and allows the smaller arteries to dilate. Hence more blood than normal flows to the brain, and *brain-action is increased.*

426. *If several drams be soon taken,* the heart beats rapidly, the face is flushed, the brain blood-tubes are gorged, and the brain-action becomes disorderly. Ideas are not correctly produced, and they often become irregular, improper, and rambling. At the same time the nerve-masses controlling muscle-movements are disturbed. Hence result the actions and movements of *intoxication* (*a*).

427. An *excess*, as in a drinking-bout, induces varying effects in different persons: some become noisy, boastful, and even quarrelsome; others cross and ugly; others lose self-control, become violent, and even acutely insane. Hence it is that persons under the influence of alcohol may commit violence and murder.

428. *Action of large amounts.* Two tablespoonfuls of whiskey have been known to kill a child! A man, on a wager, drank a bottle of French brandy in a short space

of time. Soon after finishing the liquor he became insensible, and died within sixteen hours! (*Tardieu*) (*b*).

429. *It has not been proved that alcohol can increase mental power.* It has not been proved that habitual users of alcoholics can do more or better mental work than abstainers. Alcohol "is injurious to all the functions of body and mind." (*Davis.*)

430. *Alcoholics, like opium, cause a change in the character of the nerve-cells.* They often become educated to depend upon the activities of the agent. They become unable to work without it. They usually demand an increasing amount of it. They indicate their dependence by an *overmastering craving* for alcohol or other narcotics (*c*).

431. *The steady drinking of alcoholics*, cider and beer, as well as wine and spirits, is more often the cause of permanent disease than occasional alcoholic debauches.

432. *Chronic al'co-hol-ism is a diseased condition.* It unfits its victim for sustained business. It is evinced by untruthfulness, by neglect of duties to family and to society. Its end is often in imbecility and general paralysis.

433. *The heredity of chronic alcoholism is certain.* Insanity, idiocy, instability of mind, weakness of will, and a *craving for alcoholics* occur more frequently in the offspring of the habitually intemperate than in those of water-drinkers. "The children of inebriates live on the border-land of inebriety." (*Crothers.*)

434. *The use of alcoholics lessens the feelings of care, responsibility, and discretion.* It is a potent cause of home-

discord, ill health, loss of efficiency, loss of time, and misery. It notably shortens life.

435. *It is safest to abstain from the use of alcoholics*, for it is uncertain if a person uses alcoholics or other narcotics at all that he will not end by using them in injurious amounts. "*Alcohol has no place in the healthy system.*" (*Willard Parker, M.D.*)

436. Bromides.—*When used in large amounts and continuously, bromides are not free from danger.* Their use induces pallor, loss of muscular power, and constant drowsiness. They have been known to cause weakness of mind and even brain-disease. *They should not be self-prescribed.*

437. Chloral.—*This is a dangerous drug* (170). When used improperly it causes the mind to become dreamy and dull, lessens the will-power, impairs the judgment, and blunts the mental faculties.

438. *The "chloral-habit," like the "opium-habit," is difficult to control.* Chloral is a drug which calls for increasing doses in order to produce mental rest and sleep. The steps from the moderate use to the immoderate use are gradual yet certain (430).

439. Opium.—*When used properly opium "is the finger of God."* It overcomes pain. When used continuously it ruins the nervous system. It is a drug which causes a demand for increasing doses (*d*).

440. "*Soothing Syrups*" *designed for children usually contain opium preparations.* The amount in each dose is not stated. They are dangerous compounds, for opium, even

in small doses, acts badly on most children, oftentimes causing convulsions.

441. *The "opium-habit" welds bands firmer and closer than those fastened by alcohol or chloral.* The user of opium is its slave. The will-power, memory, and moral tone of the opium-user rapidly wane, and may disappear (358).

442. **Tobacco.**—*It is an evasive agent, acting most directly on the nervous system.* It is an obstacle to proper brain-action. It impairs mental application, mental growth, and the memory (*f*).

Observation.—Under the orders of Napoleon III. the records of the government schools were kept in two classes,—those of the smokers and those of the non-smokers. After some time the records showed that the smokers were markedly inferior, physically, mentally, and morally, to the abstainers.

443. *The injurious effects of tobacco are most pronounced in the young.* It retards the proper changes in the nerve and other tissues during the growing period (71). It is highly productive of nervous troubles—irritation, nervousness, loss of power, dizziness, etc.—in the young; the younger the cigarette-smoker the more marked are the evil effects (169) on the nervous system.

444. **Coffee.**—*In sufficient amounts coffee is a nervous-system excitant.* It spurs the nerve-cells on to renewed work. It forces work out of a tired brain. It may excite muscular tremors, preventing accurate drawing (71).

445. **Tea.**—*In the form of a hot, strong infusion, tea is a nervous-system excitant.* It crowds and forces the nerve-

cells to increased activity. Its active principle is potent to banish sleep. It is a spur, not a food (*e*).

(*a*) **The Action of Alcoholics varies** with the amount of alcohol taken and the kind of alcohol taken, as well as the age, occupation, and condition of the user. "Fusel oil" (found in recent spirits) and some adulterations quicken and intensify the bad effects of common alcohol on the system. Beverages manufactured from alcohol derived from grains, beets, or potatoes (by the additions of essences, flavors, or drugs) determine cerebral and vaso-motor (ganglionic) disturbance, and impair the intellectual faculties. They have a stronger deteriorating action than wine-brandy of the same alcoholic percentage. *Natural wines* are less injurious than wines "fortified" with alcohol (Chap. XXII., *a*).

(*b*) **The Injurious Actions induced by Alcohol** are due (in part) to the sudden variations in the blood-supply of the brain. For the most part they must be assigned to the direct action of the alcohol in the blood-plasma upon the living nerve-cells. In *small doses* alcohol is a brain-excitant (stimulant). In *large doses* it is a brain-sedative (narcotic).

(*c*) **The Steady Use of Alcoholics** may fix upon the system lasting nervous disease, as *in-som'ni-a* (inability to sleep), *acute al'co-hol-ism* ("the horrors"), *chronic alcoholism* (a weakened state due to the use of alcohol), *insanity*, and a *craze for alcoholics* (dip-so-ma'nia). It must not be understood that the continued use of alcohol *always* produces such marked departures from health; yet it is true that "human misery, poverty, crime, and disease is largely produced by the use of alcoholic beverages."

(*d*) **The Early Effect of Opium is stimulating.** It braces up the mind and body. Ideas in its users flow more freely. Care and anxiety and worry are banished. *The later effect of opium is narcotic.* It causes calm, drowsiness, sleep,—even heavy, stupid, unresting sleep. The *after-effects* are horrid,—headache, nausea, heaviness of mind, mental depression, muscular weakness, and, shortly, an overmastering craving for a new dose.

(*e*) **Tea.**—When used in excess, tea more often develops *nervousness, fretfulness*, and *irritability* in women than in men. "Tea-drinkers" often become so dependent upon its exciting properties that they are unable to do their mental or physical work unless they have it "hot, strong, and often." "Tea-drinking in excess is only less harmful than alcoholic drunkenness." (*Attfield.*)

(*f*) **Tobacco-Heredity.**—"If the evil ended with the individual who, by the indulgence of a pernicious custom, injures his own health and impairs his faculties of mind and body, he might be left to his enjoyment, his fool's paradise, unmolested. This, however, is not the case. In no instance is the sin of the father more strikingly visited upon the children than in the sin of tobacco-smoking. The enervation, the hysteria, the insanity, the consumption, the suffering lives and early deaths of the children of *inveterate smokers* bear ample testimony to the feebleness and unsoundness of the constitution transmitted by this pernicious habit."

CHAPTER XXXIII.

HYGIENE OF THE NERVOUS SYSTEM.

446. *The processes which constitute the mind are carried on in the gray nerve-cells of the cerebrum* (412). In order that the processes shall be normal, five conditions are necessary: (1) the brain must be normal in its structure; (2) it must receive a due amount of normal blood; (3) its work must be adjusted to its capacity; (4) it must be worked methodically and regularly; and (5) it must be able to secure rest.

447. *For healthy and efficient action the brain should be, primarily, sound.* Every-day observation shows that children inherit not only the features, but the physical, the mental, and the moral constitution of their parents, sometimes those of the grandparents.

448. *The brain requires a due supply of pure blood.* It is estimated that one-fifth of all the blood sent from the heart goes to this organ. The effects of slight differences in the quality of the blood upon the action of the brain are real. Let a person remain for a time in a crowded, ill-ventilated hall or church, and headache or faintness is generally produced. This is caused by the action of impure blood upon the brain-cells.

449. *Use loose neck-wear, sit erect, and hold the head up.* When the head is held erect, the blood-flow to and from

the brain is least impeded. The bending of the head well forward, or the use of close neck-wear, hinders the blood-flow, and leads to overfulness of the brain-veins. The fulness causes heaviness, dull pain, and inability to do efficient work.

450. *Mind cannot grow except by growth of brain;* brain cannot grow except through good food, good air, brisk physical exercise in the open air, mental work, and mental rest in proper proportions. Most children should not be confined in school till after the sixth year.

451. *The brain should be called into action.* This organ, like the muscles, should be used, and then allowed to rest. When the brain is properly called into action by moderate study, it increases in weight and strength; while, on the other hand, if it is not used, the action of this organ is enfeebled.

Observation.—Drill the brain by the use of the eye and ear and the fingers ("manual training"), rather than by committing "long pieces" of prose or verse.

452. *Excessive and continued mental exertion is injurious at any time of life;* but in infancy and early youth, when the structure of the brain is still immature and delicate, permanent injury is more easily produced by incorrect management than at any subsequent period.

Observation.—In the lower grades of school there should be a recess hourly; in the other grades, at least once in two hours. Foul air, the forced work of a weary brain, and poor light are injurious. Encourage athletics in the young and feeble, even at the expense of mental progress.

453. *Headache, heaviness, confusion of thought, and brain-weariness in a child point to a need of rest.* Brain-overwork in children and youth often leads to permanent mental weakness. Feeble children should not study "after school" or in the evening.

454. *Regularity is of great importance in calling the brain into action.* Let us take our dinner at a certain hour for several successive weeks, and we at last find our appetite indicating its approach with the greatest regularity. The same is true of the nervous system; call it into action at regular periods, and without previous thought we enter upon that mode of action when the time approaches. The formation of "habits" is promoted by this principle.

455. *Studies that require close application should be pursued in the morning*, after a light breakfast; the best time to use the brain is during the day.

456. *We should not enter upon continued mental exertion, or arouse deep feeling, immediately after a full meal.* Such is the connection between the mind and body that, even in a perfectly healthy person, unwelcome news, sudden anxiety, or mental excitement, occurring soon after eating, will impede digestion.

457. *During brain-activity the brain-cell waste is in excess of the income.* Furthermore, wastes accumulate about the cells and in the blood. During periods of rest the wastes are removed and the losses are made good. Young or ill-trained brains require longer rest than old or well-trained brains.

458. *During sleep the brain-tissues lay up new stores of energy.* The early hours of night afford the most refreshing sleep. As a rule, all persons should average eight hours' sound sleep daily. Those engaged in mental work need more sleep than those wearied by hard labor. In winter children may well sleep from ten to twelve hours daily.

459. *Brain-rest is best secured by change of occupation.* Idleness is the worst method of attaining rest. To a young person suffering from continuous headache or from wakefulness moderate daily out-of-door work, not drugs, is indicated. All studies should cease.

INJURIOUS AGENTS.

460. *Alcoholic stimulants ought never to be used for the relief of nerve-pain* like neuralgia, or for hysteria, for in such circumstances the "alcohol-habit" is very likely to be formed. "*The children of inebriates should never drink.* The children of moderate drinkers indulge at their peril."

461. *The daily use of alcoholics* by persons under sixty years of age ought to be discouraged, for statistics show that alcoholics markedly shorten the working period of life (twentieth to forty-fifth year).

462. *The use of chloral by students and women is an increasing evil.* The sleep induced by chloral is not so restful as that produced by muscular fatigue. Chloral, being a dangerous drug (170, 438), should be taken only when prescribed by a conscientious doctor.

463. *Chloroform is more deadly than ether.* It kills sud-

denly by its action on the heart. It should not be whiffed for the relief of pain. *Ether is the safest anæsthetic.* Of all drugs now in use to banish the fear of and the pain of surgical operations, ether is the best. In cool climates it alone should be used.

464. *Opium is a dangerous yet a most essential drug.* It banishes pain. Yet in disease where pain is to be a constant symptom for months, years, and perhaps the whole life, it should not be used: (1) the nerve-cells will learn to depend upon it; (2) it will need to be taken in increasing doses; and (3) it will establish the "opium-habit" (*a*).

465. In childhood and youth *the moderate use of tobacco* hinders mental application; the *immoderate use* impairs brain-action (442). The use of tobacco should be prohibited among pupils of all grades of schools.

466. The experience of many *adults* goes to show that a moderate smoker can do more literary work than an excessive smoker. It is the opinion of many brain-workers that adults can do more mental work without tobacco than with it.

467. The investigations of Dr. Decaisne (1884) show that a *craving for alcoholics* is quite common among youthful smokers. It is the exception to find an adult who has used alcoholics in injurious amounts who did not at first use tobacco.

468. *Coffee ought not to be used by children and youths.* It not only is unnecessary to the healthy young person (306), but it has pernicious stimulating effects.

469. "*Strong tea*" *is more injurious to the nervous system than coffee.* The custom of giving children a little tea and much milk is not hygienic: it educates the child to demand an increasing amount of tea. Milk and water are the only safe drinks for children.

470. "*The practice of taking tea or coffee by students*, in order to work at night (445), is downright madness, especially when preparing for an examination. Sleep is the rest of the brain; to rob the hard-worked brain of its necessary rest is cerebral suicide." (*Williams.*)

471. *The use of quinia as a mental spur, as a "cure-all," as a "pick-me-up," is on the increase among the people.* Quinia ought not to be taken except under the advice of a physician.

(*a*) **Opium.**—It is quite probable that the *infantile opium-habit*, established by the use of "Soothing Syrups," leads to the youthful alcoholic craving and the adult "alcohol-habit." The use of opium in any form, save to relieve temporary severe pain, is always and only an evil. There is no such thing as moderation for habitual or even occasional employment of opiates outside of conscientious medical practice.

GENERAL REVIEW QUESTIONS.

Anatomy of the Nervous System.

Sum up the facts already considered. (**390, 391.**) Describe the contents of the skull-case. (**393–396.**) Speak of the spinal canal and spinal cord. (**15, 397, 398.**) How is the ganglionic system made up? (**400.**) Mention the three varieties of nerves and their distribution. (**401–404.**) Of what is the nervous system composed? (**405–407.**) What structural changes may alcohol induce? (**408.**)

Physiology of the Nervous System.

What cerebral functions have been localized, and how? (**410-413.**) What is the duty of the cerebellum? (**415.**) What functions have their seat in the medulla? (**416.**) Mention the duties

of the spinal cord. (417–419.) What is controlled by the ganglionic system? (420.) Physiologically, how do nerve-fibres vary? (421, 422.) Summarize the work of the nervous system. (424.)

Action of Injurious Agents.

How does alcohol influence brain-action: (*a*) small dose, (*b*) several doses, (*c*) an excess, (*d*) a very large dose? (425–428.) What may alcoholic indulgence induce? (430.) What results from the continued use of alcoholics? (431–433.) Why is temperance advisable and safe? (434, 435.)

Give reasons against the common use of bromides and chloral. (436–438.) What are the actions of opium? (439–441.) State facts about the action of tobacco on the young. (442, 443.) How do tea and coffee affect brain-action and brain-health? (444, 445.)

Hygiene of the Nervous System.

What conditions are essential for brain-health? (446.) How does the blood influence brain-action? (448, 449.) What is essential for proper brain-work? (450–453.) How should the brain be managed? (454–456.) Why is sleep needed? How much? (457–459.)

Who should not use alcoholics? (460, 461.) Why should not chloral be commonly used? (462.) Why is ether preferable to chloroform? (463.) State the dangers incident to the use of opium. (464.) Speak of tobacco and mental work. (465–467.) When should students avoid tea or coffee? (469, 470.) Mention some improper uses of quinia. (471.)

BLACKBOARD ANALYTIC SUMMARY OF THE NERVOUS SYSTEM.

(Chapters XXX.–XXXIII.)

ANATOMY OF . . . { *Brain* . . { Cerebrum. / Cerebellum. / Pons. / Cranial Nerves.

ANATOMY OF . . .

- *Spinal Cord.*
  - Medulla.
  - Cord.
  - Spinal Nerves.
- *Ganglionic System.*
  - Ganglia.
  - Ganglionic Nerves.
- *Structural Elements.*
  - Nerve-Cells.
  - Connective Tissue.
  - Nerve-Fibres.
    - Motor.
    - Sensory.

PHYSIOLOGY OF .

- *Cerebrum* . Will, Thought, Intelligence, Speech, General Control.
- *Cerebellum* . Organ of co-ordination.
- *Medulla* . . Seat of vital centres.
- *Spinal Cord.*
  - Conductor of impulses.
  - Centre of certain reflex actions.
- *Ganglia* . . Centres of nerve-impulses.
- *Nerves* . . Conductors of nerve-impulses.

HYGIENE OF . . .

- A normal mental and moral predisposition.
- Abundant supply of healthy blood.
- Proper regulated brain-work.
- Ample physical exercise.
- Adequate regular brain-rest.
- Non-abuse of stimulants and narcotics.

AVOIDABLE CAUSES OF ILL HEALTH.

- Alcoholic brain-exciting action.
- Alcoholic brain structural changes.
- Alcoholic heredity.
- Bromide or chloral stupefaction.
- Opium functional disorders.
- Tobacco toxic action.
- Tobacco heredity.
- Tea or coffee nervous excitation.

CHAPTER XXXIV.

NUTRITION.

472. *During life there is a constant movement in the semi-fluid substances making up the bulk of the body.* The changeful state of the body is shown by the losses to which it is subjected; by the necessity of food; by the emaciation which follows abstinence from food.

473. **Nutrition** is the vital act by which the different parts of the body renew the materials of which they are composed.

WORK OF THE BLOOD.

474. **The Living Blood** is fluid and always in motion. In the healthy blood-vessels it does not coagulate. Outside of the blood-vessels it separates into the *clot* (a semi-solid mass) and *serum* (a yellowish fluid) (143).

475. *The red corpuscles take in new loads of oxygen in the skin and lungs* (158). They convey it to all parts of the body. They readily part with a portion to any living tissue which wants it. They return to the lungs partially empty.

476. *The living plasma does the great work of the blood.* Unlike the corpuscles, it can penetrate into every nook of the body, as the white cartilages, the cornea of the eye, etc. It contains the foods for the body-particles (157).

477. *The living plasma offers to each living particle of the body that which the particle wants of the best it has.* It removes from the particles the wastes formed in or near them. By absorption (273) it receives new materials to renew itself. How the work of nutrition in the particles is done is not known.

478. Growth.—Living organisms have the power of taking in materials different from themselves (foods), and making them into substances like the body-substances. Increase in bulk of the living body comes from taking of food-materials from the plasma. Growth is increase of bulk (*a*).

479. Injurious Agents.—Alcohol, the active parts of opium, tobacco, coffee, and tea, in the plasma, injure the blood. Experience shows that in the immature body they hinder repair and growth.

BODY-WORK.

480. *The human body is a living machine.* It takes in foods. It makes the foods, by changes effected in the body, a part of itself. It works; it wears; it repairs itself; it shows activities.

481. *The principal activities of the living human body are* body-motions (chewing, talking, grasping, moving objects, as in daily work, and walking), digestion, absorption, circulation, respiration, growth, heat-production, body-work, secretion, and the changes exciting feeling, thought, memory, and will.

482. *Foods are essential to the working, growing, living*

body. To sustain the *body-heat*, fats, sugars, and starches are best. To supply *power*, fats, starches, and proteids are best. To make *repairs*, all kinds must be provided. To keep up the *vital action*, oxygen must be supplied.

483. *The active parts of stimulants and narcotics do not supply force to the healthy human body.* They do not, alcohol excepted, afford heat. They should, therefore, be taken only as medicines.

THE WASTES.

484. *The work of the body causes the tissues and cells to wear away.* The worn particles are waste. They collect in the plasma. They should be quickly cast out.

485. Waste Matter is cast out of the plasma of the blood
- *By the Skin* (111).
- *By the Lungs* (333).
- *By the Kidneys* (255).
- *By the Bowels* (272).

486. *If wastes accumulate in the blood, debility and disease will result.* Hence the *skin* should be kept clean (134); the *movements of the walls of the chest and abdomen* should not be impeded (354); *the region of the kidneys* should be kept warm; and the *constipated habit* ought to be prevented (303).

Observation.—In disease the measures of the physician are largely shaped to sustain the system and to re-establish the proper action of the skin, lungs, kidneys, and rectum.

(a) **Growth.**—At birth the child is about one-third of the maximum length and about one-twentieth of the maximum weight. A healthy adult should weigh not less than two pounds for each inch of stature.

CHAPTER XXXV.

ANIMAL HEAT.

487. Composition of the Body.—About sixty-eight per cent. of the living body is water. The rest of the body is made up largely of carbon-compounds (*a*).

Examples.—Charcoal is nearly pure carbon; wood is largely made up of carbon; the grains are rich in carbon; flesh contains a large amount of carbon.

488. *Oxidation is burning.* When charcoal is set on fire, when air is allowed to reach it, then it burns. It in burning gives forth much *heat*, much *carbonic acid gas*, and a little *light*.

489. *The amount of heat set free is the same whether the burning occurs rapidly or slowly.* Thus, a pound of charcoal burning in the brazier and a pound burning rapidly in the furnace set free the same amount of heat.

490. *The human body and its foods are rich in compounds which may be burnt.* The burnings occurring in the body take place slowly. They set free *heat* and produce wastes (*carbonic acid*, *water*, and *urea*).

HEAT-PRODUCTION.

491. *Experiments show that little or no burning takes place in the blood.* Most of the burnings occur in or near the muscles, the brain, the liver, and the digestive organs.

492. *Heat is set free during every change occurring in the body*, as thinking, exercising, talking, working, secreting, digesting, etc. It is also set free in the changes which the food undergoes in the digestive canal.

493. *In order that oxidation may occur in the living body*, (1) The tissues must be supplied with *oxygen*. Hence *breathing* and *blood circulation* must be unhindered. (2) The *ashes* (urea and mineral wastes) and the *smoke* (carbonic acid and vapor of water) must be rapidly removed. Hence the *kidneys*, the *lungs*, and the *skin* must work freely (485).

Illustration.—In order that the fire in the stove may burn freely the draught-damper must be opened, the ashes shaken out of the grate, and the back-damper of the pipe opened fully.

HEAT-LOSS.

494. *The body-heat is being continually lost, as well as constantly produced.* About three-fourths of the body-heat passes away by the skin, about one-fifth in warming the air-passages, and the rest in warming the excreta (*b*).

495. *The temperature of men is about* 99.6° F. (37.5° C.). This average is maintained in all climates, among all men. In health heat-loss balances heat-production. When we exercise the heat set free is increased, but the loss from the air-passages and from the skin is also increased, and the temperature only rises slightly.

Observation.—In fever there is an abnormal elevation of temperature (101° to 107°, and even 112° F.), for

heat-production is increased and heat-loss is diminished from the lessened action of the skin and kidneys.

496. *The temperature is regulated by the nervous system.* By its control over the size of the arteries (420) it allows, when the temperature is rising, more blood to go to the skin (increasing heat-loss), and less to the liver, digestive organs, etc. (lessening heat-production). Hence the balance is soon restored. In health this nervous control acts promptly and efficiently.

Illustration.—Sir John Richardson, who went to the Arctic regions to search for Franklin, was able to expose himself for a quarter of an hour without his great-coat while making a magnetic observation (the outer temperature being often as low as —50° F., while that of the hut was +50° F.) without ill effects.

ALCOHOL AND BODY-HEAT.

497. *Small quantities of alcohol,* when taken by a healthy adult, disappear in the system. All the alcohol given in careful experiments has not been recovered in the urine, perspiration, breath, or fæces.

498. *Alcohol, like sugar and starch, contains carbon in a form suitable for burning.* Alcohol disappears in the system. Hence it is held that alcohol is burnt in the system (*c*).

499. *Alcohol overcomes the nervous control of heat-regulation.* Average drams and large drams, in the temperate, cause the skin to become deeply flushed and, in cold weather, the heat-loss to be largely increased, followed

by a fall in the body temperature. In brief, heat may be set free from the alcohol consumed, but it is much less than the heat lost through its overcoming nerve-control (*d*).

Observation.—When intending to ride on a cold day, wash the face, hands, and feet in cold water, and rub them smartly with a coarse towel. Never take alcoholics before exposing yourself to unusual cold.

500. *Alcohol does not fortify against the cold.* Alcohol, in the coldest regions, is not only useless, but is actively injurious. The experience of almost every Arctic explorer is that total abstinence from alcoholics, while under exposure, is essential for the prevention of frost-bites and the preservation of life.

501. *Alcohol does not aid the system to withstand the effects of severe heat.* The Europeans who persist in the use of strong alcoholics while living in the tropics most often suffer from tropical diseases, and earliest succumb to the climatic influences.

502. *Alcohol is not a preventive of disease.* In the *French cholera epidemic of* 1884, the intemperate users of alcoholics predominated among the earlier victims. The death-rate in that class was much higher than among the temperate and the abstainers. (See ¶ 356.) It is the general belief in New Orleans and Mobile that the victims of *yellow fever* are chiefly those who drink freely. (*Drake.*)

503. *Alcohol in any form is not needed by the healthy.* It ought to be used only as a medicine (*e*). Most feeble and ailing people need no alcoholics. Hence they should

abstain from the use of "bitters," "patent tonics," and other alcoholics.

(*a*) **The Average Chemical Composition of the Body** is about as follows:

Oxygen	72.	Carbon	13.5	Potassium	.026
Hydrogen	9.1	Phosphorus	1.15	Iron	.01
Nitrogen	2.5	Calcium	1.3	Magnesium	.0012
Chlorine	.085	Sulphur	.1476	Silicon	.0002
Fluorine	.08	Sodium	.1		

These elements are variously combined, forming definite organic and inorganic compounds.

(*b*) *Experiment.*—Place a few drops of alcohol on the skin. It rapidly changes to a vapor (evaporation); it takes heat from the skin, and the skin feels cooler. The same occurs when water is used, or when the perspiration moistens the skin.

(*c*) **Utilization of Alcohol.**—"It is certainly deducible that *alcohol* in small amounts is an *arterial* and *cerebral stimulant*, increasing functional activity in the nervous and circulatory apparatus; that it is a *food*, in the sense that it is destroyed in the system and yields force which is utilized by the organism; and that it is, when in sufficient quantity, a retarder of tissue-changes, checking the excretion of nitrogen." (*H. C. Wood, Prof. in Univ. of Penn.*, 1891.) "The decomposition of the food-mass prior to its passage through the ileo-cæcal valve is confined to carbohydrates (fats, starches, sugar). The products formed by the bacteria in the small intestine are lactic, paralactic, acetic, succinic, and carbonic acids, hydrogen, and *ethyl alcohol*." (*Macfadyen and Nencki*, 1891.) "Fats, sugars, starches, and alcohol (ethyl) yield to the living body heat, energy, rotundity, and act as lubricating agents, and are excreted from the living body as carbon-dioxide (carbonic acid) and water." (*Prof. W. H. Porter, at Nat. Temp. Med. Congress, July* 1891.)

(*d*) Dr. Anstie reported the case of a London tailor who lived on a bottle of gin and a small piece of white bread daily, as his only sustenance for years. It is certain that the system is able to use considerable amounts of alcohol and to derive heat and force from the same. It is true that shipwrecked persons and Arctic explorers have lived for some time on alcoholics alone. Yet with all these possibilities, *alcohol is not a good article of food, is not a necessary article of food.* Experiments show that alcohol as a heat-producer in the healthy body is vastly inferior to sugar, starches, and fats. It certainly in America is not an economical food.

(*e*) **A Measure of Alcohol** which produces in a person a sudden effect, flushes the face, or exhilarates, is a toxic dose for that person. Such a dose is usually followed by a depression felt throughout the system. It is a quantity short of this which is allowable. One-fourth to one-half a teaspoonful of alcohol in much liquid may be a commencing dose. Frequent small doses produce the best effects. Ethyl alcohol is preferable to spirits, wines, or beers for most medicinal purposes, because it is pure, and it can be accurately and readily measured.

GENERAL REVIEW QUESTIONS.

Nutrition.

What occurs during life? (472.) What is nutrition? (473.) Describe the changes in coagulation. (474.) State the duties of the blood-components. (475–477.) How is growth manifested? (478.)

Body-Work.

Mention the activities of the living body. (480, 481.) What food-substances should be provided? (482, 483.) How do the wastes arise? (484.) How are they eliminated? (485.) How is their casting-out aided? (486.)

Animal Heat.

State the composition of the body. (487.) What is oxidation? How manifested? (488, 489.) How is heat evolved in the living body? (490–492.) What is essential for heat-production? (493.)

Heat-Loss and Heat-Regulation.

How does heat leave the body? (494.) How is an average temperature maintained? (495, 496.) Why is alcohol considered a food? (497, 498.) How does alcohol encourage heat-loss? (499.) What conditions contraindicate the use of alcoholics? (500–503.)

BLACKBOARD ANALYTIC SUMMARY OF THE WORK OF THE LIVING BODY.

(Chapters XXXIV., XXXV.)

- WORK OF
  - Red Corpuscles.
  - White Corpuscles.
  - Plasma.
  - Interchanges.
- NUTRITION.
- GROWTH.
- HEAT-REGULATION
  - Heat-producing areas.
  - Heat-loss areas.
  - Vaso-motor actions.

BODY-WORK	Incessant changes. Voluntary movements. Involuntary movements. Heat-production. Waste-formation.
ELIMINATION OF	Carbonic acid. Vapor of water. Nitrogen wastes (urea, etc.). Other wastes.
AVOIDABLE CAUSES OF ILL HEALTH.	Alcoholic blood-changes. Alcoholic heat-loss. Alcoholic preparation for disease. (*a*) Consumption. (*b*) Cholera. (*c*) Yellow fever. (*d*) Heat-stroke. (*e*) Frost-bite.

CHAPTER XXXVI.

THE SPECIAL SENSES.

504. Sensation.—When the brain receives impulses coming over the sensory fibres we are conscious of a feeling or *sen-sa'tion.* The sensations of *weariness* and *fatigue* appear to come from within us. Sensations of *odor*, of *taste*, of *sound*, and of *sight* are transmitted to us from without the body.

505. The Mechanism necessary to produce a sensation is made up of three parts: (1) a *nerve-ending;* (2) a *sensory*

nerve-fibre; (3) *the brain.* Thus, the waves of light and color coming from a picture enter the eye and form a small but perfect picture on the retina in the back part of the eye (Fig. 58, ⁵); the sensory fibres (optic) conduct special impulses to certain parts of the brain (Fig. 53). The mind, owing to actions in the brain, then becomes conscious of the form, appearance, and color of the picture.

506. *Sensations are of two kinds, general* (pain, temperature), and *special* (touch, taste, smell, sight, hearing, position).

TOUCH.

507. Touch is the sense that enables us to tell whether a body is rough or smooth, cold or hot, sharp or blunt. The *nerve-endings* of this sense are found for the most part in *tactile papillæ* (Figs. 16 and 54) and nerve-endings of the skin. They are less numerous in the mucous membrane.

Observation.—A hard or soft body, a hot or cold body, in the mouth excites definite sensations; in the stomach or intestines only a general sensation of *pain* (*a*).

508. Touch *is modified by the condition of the brain and nerves;* by the quantity and quality of the blood supplied to the skin; by the thickness of the epidermis; and by cultivation.

Observation.—Blind persons cultivate this sense to such a degree that they can distinguish objects with great accuracy.

509. Care of the Fingers.—By care the fingers can be

given greater scope for sense-activity. The fingers, if delicacy of touch is desired, should be washed no oftener than absolutely necessary. They should never be put in hot water. For cleansing the fingers, use fine soap, ammonia-water, and a brush. It is preferable to file rather than cut nails. The under surfaces of the nails are best cleaned with a toothpick or an ivory cleaner.

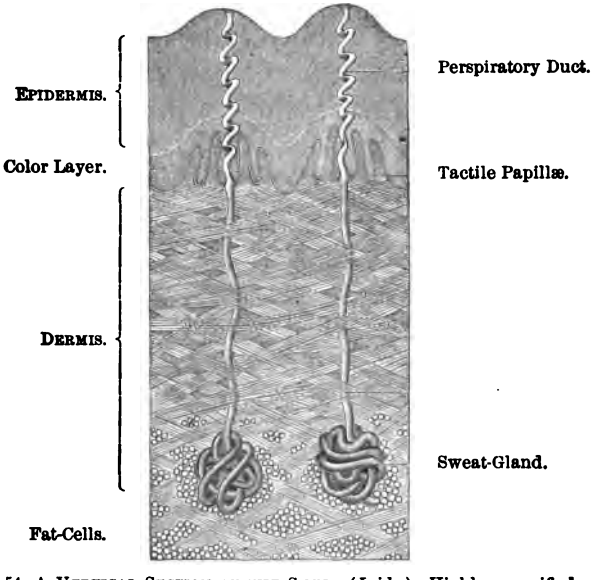

Fig. 54. A Vertical Section of the Skin. (*Leidy.*) Highly magnified.

510. Alcohol and Touch.—The careful experiments of Dr. Ridge (1881) show that small doses of alcohol cause a slight falling off in acuteness. The continuous use of alcohol has been found to markedly blunt this sense.

TASTE.

511. Taste.—The *nerve-endings* concerned with this sense are mainly located in the tongue. (Fig. 55.)

512. The Papillæ are the minute projecting points seen

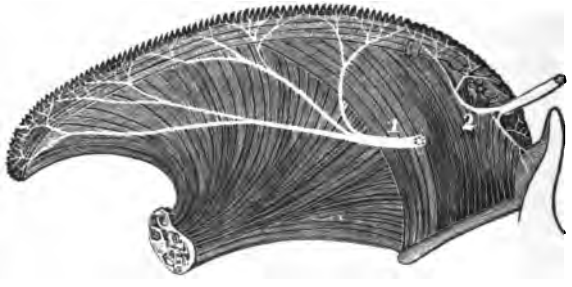

FIG. 55. VERTICAL SECTION OF TONGUE, showing the muscular fibres, the papillæ on the dorsum, and the distribution of the fibres of the "gustatory" branch of the Fifth cranial (1), and of the "dis-gustatory" branch of the Ninth cranial (2).

on the back of the tongue. On applying vinegar to the tongue, with a hair-pencil, these points will become curiously lengthened.

513. *Substances, to be tasted, must be either naturally fluid, or partially dissolved by the saliva.* When fluids are taken into the mouth, the particular impression excited is carried to the brain (Fig. 53) by the nerves of taste. But if dry, solid food is taken, it must be acted upon by the saliva before the impression is perceived.

514. *The use of taste is to guide men and animals in the selection of their food,* and to warn them against the introduction of injurious articles into the stomach. This sense has been made to vary more than any other by the refinements of social life.

515. *This sense is modified by habit*, and not unfrequently those articles which at first were disgusting are rendered highly agreeable by persevering in the use of them, as in learning to chew tobacco, to eat onions, curry, etc.

516. *Taste, as well as touch, may be improved in acuteness.* Tasters of wines and teas can discriminate shades of flavor not perceivable by ordinary persons.

517. *Many persons impair their taste by bad habits*, as chewing or smoking tobacco, and using stimulating and narcotic drinks. These indulgences usually lessen the sensibility of the nerves, and injure the natural relish for food.

SMELL.

518. **Smell.**—The *nerve-endings* (Fig. 56, [5]) of this sense are located in the mucous membrane lining the air-passages of the nose. (Fig. 31.)

519. The *mucous membrane* of the upper part of the nostrils secretes a thin, watery mucus. This keeps the upper part of the nasal passages in a condition favorable for the action of the odorous particles on the nerve-endings.

520. *Smelling.*—When substances are presented to the nose, the air that is passing through the nostrils brings the scented particles of matter in contact with the filaments of the nerve of smell. The impression generated is then carried to the brain. (Fig. 53.) The great function of smell is to warn against air impurities.

Observation.—The North American Indians and the Zulus can easily distinguish different tribes and different persons of the same tribe by the odor of their bodies.

521. *Acuteness of smell requires that the brain and nerve of smell be healthy, and that the membrane that lines the nose be thin and moist.* Any influence that diminishes the sensibility of the nervous filaments, thickens the membrane, or renders it dry, impairs this sense.

FIG. 56. A VERTICAL SECTION OF NASAL PART OF THE FACE, MADE IN THE MIDDLE LINE.—4, The olfactory bulb of the first cranial nerve, lying within the skull. 5, The filaments of the bulb hanging down into the upper part of the nostril (the covering mucous membrane having been cut away).

522. *Snuff, when introduced into the nose, not only diminishes the sensibility of the nerve but thickens the lining membrane.* This thickening of the membrane obstructs the passage of air through the nostrils, and thus obliges "snuff-takers" to open their mouths when they breathe.

523. *The sense of smell is blunted* by the use of snuff, by the immoderate use of smelling-salts and powerful perfumes, and by the persistent inhaling of smoke, dust, and the odors arising from filthy streets, from accumulations of decaying vegetables in cellars, and from sewers and cesspools.

(*a*) **FOR THE TEACHER. Experiments.**—With a pair of sharp-pointed dividers test the sensitiveness of the skin. Place the two limbs at such a distance apart as shall, when both are pressed simultaneously, excite the sensation of two pricks. Push the limbs nearer and nearer until the two points will excite only one sensation. Repeat the tests for different parts of the body. It will be found that the tip of the tongue, the palms of the last phalanx, and of the second phalanx of the finger are the most sensitive, and that the back, the sternum, the forearm, and the back of the hand are the least sensitive parts of the human body. At another part determine by *light* pressure the nearest distance for two sensations. Now press heavily, and only one sensation will be recognized. Light pressure gives a clearer sensation than heavy pressure.

Blindfold a person. Place a marble or other smooth uniform body between the forefinger and middle finger; the presence of one body will be recognized. Bend the middle finger over and beyond the forefinger, and then place the marble in the fork thus formed so that it touches the radial side of the forefinger and ulnar side of the middle finger; the presence of two bodies will be recognized. This is an error of judgment, because in ordinary affairs these two portions of the skin cannot be touched by one object at the same time.

CHAPTER XXXVII.

SIGHT.

524. In the back part of the eye are located the *nerve-endings* concerned with the sense of sight (*a*).

ANATOMY OF THE ORGANS OF SIGHT.

525. The Eye is shaped like a globe, and is placed in a cavity in the front of the head. (Fig. 2.) The sides of the globes are composed of *coats*, or membranes, and the interior of the globe is filled with substances called *Hu'mors.*

526. The Membranes.—The *sclerotic* (skle-rot'ik) *coat* is firm, and its color white; hence it is frequently called

the "white of the eye." (Fig. 58, H.) The *cornea* is the transparent part of the eye in front, which projects more than the rest of the globe (A). The *con-junc-ti'va* is a mucous membrane found on the outer surface of the cornea and lining the eyelids (G). The *choroid* (ko'roid) *coat* is of a dark color upon its inner surface (I).

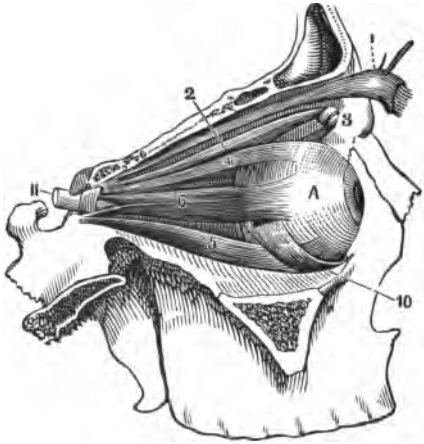

FIG. 57 (*Leidy*). THE EYEBALL AND ITS MUSCLES. (A portion of the bones of the orbit has been cut away.)—A, The eyeball. 1, 2, 4, 5, 6, 10, Muscles. 3, The loop through which the tendon of the muscle which rolls the eye downward works. 11, Optic nerve.

527. **The Iris** is situated a short distance behind the cornea. It contains circular and radiating muscular fibres. It gives the blue, gray, or black color to the eye. (Fig. 58, D.) In the centre of the iris is an opening called the *pu'pil*, which enlarges or contracts, according to the quantity of light that falls upon the eye (C).

528. **The Retina** is the innermost coat of the eye. It

is formed, in part, by an expansion of the optic nerve over the bottom of the eye. (Fig. 58, K.)

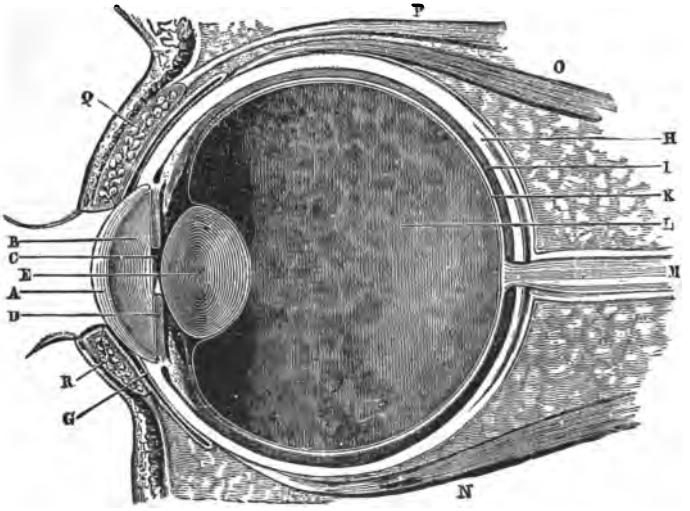

FIG. 58. THE HUMAN EYE, as seen in section in position.—A, Cornea. B, Aqueous humor. C, Pupil. D, Iris. E, Lens. H, Sclerotic coat. I, Choroid coat. K, Retina. L, Vitreous humor. M, Optic nerve. N, O, P, Muscles. Q, R, Cut surfaces of eyelids showing the glands.

THE MEDIA, OR HUMORS.

529. The Aqueous Humor occupies the space between the cornea and lens, both before and behind the iris. It is like a few drops of water. (Fig. 58, B.)

530. The Lens is like a "burning-glass," except that the rear surface is more bulging than the front. It is transparent. (Fig. 58, E.)

Observation.—When the lens, or the membrane which surrounds it, is changed in structure, so as to prevent the

rays of light passing to the ret'i-na, the affection is called a *cataract.*

531. The Vitreous Humor is situated in the back part of the eye. It occupies more than two-thirds of the whole interior of the globe of the eye. It is glassy in appearance. (Fig. 58, [L].)

532. The Optic Nerve, or nerve of vision, extends from the brain to the back part of the eye, where it expands in the retina. (Fig. 58, [M].)

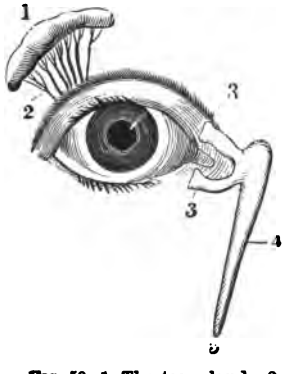

FIG. 59. 1, The tear-gland. 2, The ducts that pass from this gland to the eye. 3, 3, Ducts at the inner corner of the eyelids. 4, The duct that leads into the nose.

APPENDAGES OF THE EYE.

533. The Eyebrows protect the eye from too strong impressions of light, and prevent the perspiration from flowing into it. The *eyelashes,* when the eye is nearly closed, prevent particles of matter from injuring this delicate organ.

534. The Eyelids not only protect the eye, by closing it in front, but distribute equally over the globe of the eye the secretions of the conjunctiva and the tear-glands.

535. The Tears are secreted by the tear-glands (*Lach'ry-mal*), situated in the orbit above the eyeball. (Fig. 59, [1].) The tears flow to the eye by several minute ducts ([2]).

536. The Tear-Ducts usually convey the tears away as

quickly as they are formed through the *nasal duct* (Fig. 59, 4) to the nose; but when the eye is irritated, or the mind affected by emotions, they flow to the eye too rapidly to be conveyed to the nose, and they then course down the cheek.

537. Eye-Muscles.—The eyeball is moved by six muscles, one extremity of each being attached to a bone in the orbit, the other extremity to the globe of the eye. (Fig. 57.) Within the eyeball are muscular fibres which make the lens less bulging. There are muscular fibres in the iris.

PHYSIOLOGY OF VISION.

538. *The eye is an optical instrument*, a kind of camera (*b*). Its *coats* form the dark chamber; its *iris* acts as the diaphragm; its *lens* is, in action, like one made of glass; and the *retina* corresponds to the ground-glass plate. (Fig. 58.)

539. Eye Refraction (*c*).—When the parallel rays of

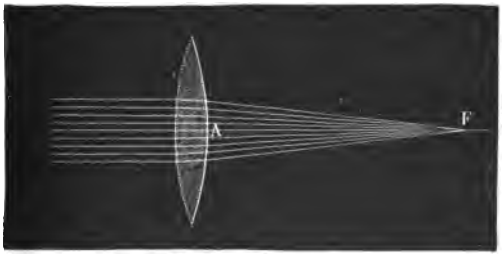

FIG. 60. PARALLEL RAYS BROUGHT TO A FOCUS.

light pass through a lens of glass, like a "burning-glass," they meet together behind the glass. (Fig. 60, F.) When

the rays of light coming from a distant object pass through the lens of the eye they form a small inverted picture on the retina. (Fig. 61, B.)

540. Functions.—The *eyebrows*, *eyelids*, *eyelashes*, and the *tears* are protecting agents for the delicate exposed

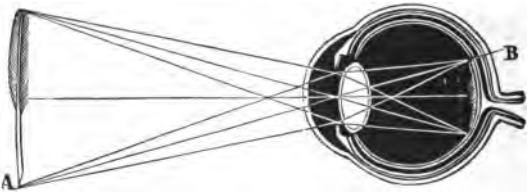

FIG. 61. REFRACTION OF THE LENS.—A, A pen, an inverted image of which is painted on the retina of the eye, at B.

surfaces of the eye. The transparent *cornea* and the firm *sclerotic* give form to the eyeball. The black *choroid* absorbs stray rays of light. The nerve-endings in the *retina* send impulse-impressions over the optic nerve to the brain (Fig. 53), and we are able to see.

The *cornea* permits the light to enter the eye. The *iris* regulates the amount of light entering the deeper parts. The *lens* refracts the rays of light. (Fig. 61.) The *aqueous* and *vitreous humors* enable the lens to do its proper work by keeping the eyeball filled out.

541. Near Objects.—When we try to see *very* near objects, we roll the eyes inward, make the pupils smaller, and strain. During the straining, the muscular fibres within the eyeball (537) relax the membrane of the lens and the elastic lens becomes more bulging. (Fig. 62, N.) Hence the lens becomes more powerful, a picture now

forms on the retina, and we then can see the near, or small, object.

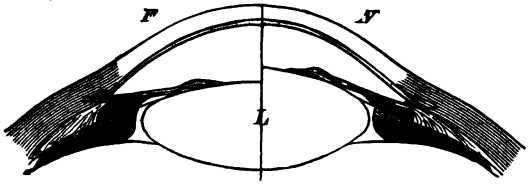

FIG. 62. DIAGRAM SHOWING CHANGE IN FRONT SHAPE OF LENS IN ACCOMMODATION (from *Helmholtz*).—*L*, Lens. *N*, The lens adjusted for near vision. *F*, The lens adjusted for common vision.

In the healthy eye this *accommodation* is done rapidly, efficiently, and without conscious effort for near, distant, and very distant objects. In the "near-sighted" eye it is imperfectly done, and hence objects appear blurred.

HYGIENE OF THE ORGANS OF SIGHT.

542. *The eye, like other organs of the body, should be used, and then rested.* If we look intently at an object for a long time, the eye becomes wearied, and the power of vision diminished. When the eyes become weary, cease using them. Better be less intelligent than feeble in body and in vision.

543. *Sudden transitions of light should be avoided.* The iris enlarges or contracts as the light that falls upon the eye is faint or strong; but the change is not instantaneous. Hence the imperfect vision in passing from a strong to a dim light, and the overwhelming sensation experienced on going from a dimly-lighted room to one brilliantly lighted.

Observation.—So arrange the bed that upon awaking the sun shall not shine in the eyes. This is especially important as regards infants.

544. *Sunlight is the best light.* Too much, too dazzling, or too little light is hurtful. Let the sunlight come upon the work from above, behind, and the left side. Evening twilight affords a dangerous light.

Observation.—For the sake of the eyes, do all studying and close eye-work by daylight. Letter-writing and copying are more suitable for evening work than reading.

545. *Artificial lights should be white, uniform, and steady.* A white porcelain shade, with a green outer surface, is to be commended. As a rule, the light ought to be placed to the left front of the worker, the flame being slightly above the level of the eyes.

546. *Secure a pure and a clear air.* Tobacco-smoke, fire- or lamp-smoke, dust, and emanations from steaming dirty clothing are injurious to young eyes. The eyes, the spectacles, the window-panes, and the lamp-chimneys should be kept clean.

547. *Weak children should not be sent to school until they have been brought into a state of fair health by out-of-door pursuits.* The probability of harm resulting from school-life diminishes with every added year. Weak children ought never to read or study by lamp-light (*d*).

548. *A near-sighted person cannot see the fixed stars distinctly.* He can see near objects very distinctly. In most cases the axis of the eyeball is too long. (Fig. 63.) The great cause of "near-sight" is a too early and too pro-

longed eye-strain upon small objects by young and feeble children.

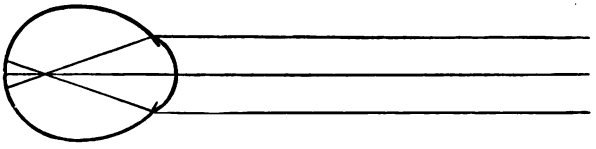

FIG. 63. DIAGRAM OF A NEAR-SIGHTED EYE.—The image is formed in front of the retina, not on it, as in Fig. 61.

549. *Every near-sighted child, youth, or adult should be provided with glasses which will make seeing easy and clear within six to ten feet.* For near work, the glasses should enable the person to see distinctly ten to twelve inches from the eyes (*e*). Each eye should be fitted. Spectacles are better for the eyes than eye-glasses. The near-sighted should not bend over their work nor hold their heads near hot lights (*f*).

550. Alcoholics, when used in excess, have been known to cause cataract and disease of the retina. Tobacco and alcohol, when used in excess, may induce weakness of vision (*tobacco-amblyopia*).

551. *Tobacco-smoke* irritates the eyes. It not unfrequently causes acute pain, heat, grittiness, and redness of the eyeballs. The excessive use of tobacco by the young has been known to cause permanent disease of the retina (feeble, confused vision). *Tobacco-chewing* is as harmful to the internal parts of the eye as smoking.

(*a*) FOR THE TEACHER. Directions for Dissection.—If possible, procure a salmon-head (the bones are mostly cartilaginous); if not, then one of a calf or pig. Saw out the portion of the skull holding the eye. Note the *eyelids*, the *eyelashes*, the *conjunctiva* (lining the eyelids and forming a thin membrane over the front of the

eyeball), the transparent *cornea*, and the white, firm *sclerotic* membrane. Remove the bone above and behind the eyeball. Note the *fat* back and around the rear of the eyeball, the *four straight muscles*, the *two oblique muscles*, and the *white optic nerve* extending back through the *optic foramen* (opening) to the *brain*.

Freeze several eyes (fish-eyes will do) by placing them in snow overnight, or using ice and salt. Dissect away all fat and muscle. Hold the frozen eye between the thumb and forefinger, resting the lower surface of the eye on a thick slice of potato. With a sharp knife or razor divide the eye into halves. Allow the cut surface to rest uppermost. Note in front the bulging *cornea*, the ice of the *aqueous humor*, the *iris*, with its opening, the *pupil*, the hard *lens*, the frozen *vitreous* humor, and the *membranes* forming the walls of the eyeball.

Secure a large, fresh eye (ox, pig, or sheep). Hold it with the cornea uppermost. Puncture the cornea, and a small amount of limpid fluid—the *aqueous fluid*—escapes. With fine embroidery scissors cut the cornea from the sclerotic close to its union with the latter. The cornea is seen to be transparent, of nearly uniform thickness, and watch-glass-shaped. Note the *iris*, its free edge bounding the dark opening called the *pupil*, and resting on the anterior surface of the capsule of the lens. On the front surface of the lens make a shallow, cross-shaped incision. Under slight pressure with the handle of the scalpel the *lens* will escape from its capsule. Notice the difference in curvature between its front and rear surfaces, the firmness of its tissues, and its transparency. Cause a ray of light to pass through a fresh lens, and note its *refracting* power. Behind the bed in which the lens rested will be seen the glassy *vitreous humor*. Allow the vitreous to escape.

Place the coats in a shallow dish of water. Looking into the hollow of the ball, note the entrance at the fundus of the *optic nerve* and the blood-vessels radiating from that spot. Separate the inner thin membrane, the *retina*, from the next membrane, the *choroid*. Observe that the retina appears like an expansion of the optic nerve, and that most of the *black pigment* adheres to the choroid. Outside of the choroid is seen the *sclerotica* of the posterior part of the ball.

(*b*) **Demonstration.**—Select a boy having a large ocular fissure and a prominent eye. Call the attention of the class to the *eyebrows* (the direction of the hair), *eyelids*, and *eyelashes*. Gently pull down the lower lid. Demonstrate the junction of the mucous membrane and the skin, the place of implantation of the lashes, the fifteen to twenty openings on the free edge of the lid (outlets of the *palpebral gland-ducts*), and the slight elevation on the margin near the inner angle, which has an opening (*puncta*). Gently seize the lashes of the upper lid, hold a small pencil on the upper lid, from three-eighths to five-eighths of an inch from the margin, direct the student to look down, then quickly evert the lid. Note the pink, moist mucous membrane, the *conjunctiva*, and the outline of the *tarsal cartilage* pressing on the conjunctiva. The small triangular space at the inner angle, the *lacus*, contains a small reddish, conical body, the *caruncle*. This is the source of the whitish secretion which collects at the inner angle.

Point out the loose, clear, white, thin *conjunctiva* overlying the sclerotica; the white or yellowish-white *sclerotica*, the clear, transparent *cornea*, the black *pupil*, and

the various-hued *iris*. Place a lamp to the right and a little in front of the face of the student. With a convex lens between the lamp and the eye direct a pencil of rays on to the cornea. Then call attention to the *cornea*, its form and scleral junction, the *anterior chamber*, containing the *aqueous humor*, the *iris*, and the *lens*. Note the ready contraction and dilatation of the pupil under varying amounts of light.

(*c*) **Experiments.**—Remove the front convex lens from a pair of opera-glasses, or procure a convex lens with a gradual curve. Hold it opposite a window, and place a piece of white paper behind it to act as a screen. A small reversed picture of the window-frame will appear on the paper. If the paper be moved to a certain distance, varying with each lens, the picture will become clear and distinct, yet with color-rings about the edges. At that distance from the lens the paper is said to be *in focus*. If the paper be moved nearer to, or farther from, the lens, the picture becomes blurred, and the paper is said to be *out of focus*.

Visit a photographer's studio. Request him to point out and name the uses of the essential parts of the camera,—the blackened box, the ground-glass screen, the lens, the diaphragm, and the apparatus for adjusting the lens and the screen to the object. Watch him place the camera and then work the ground-glass screen into the proper focus. When all is ready, put your head under the curtain of the camera and study the reversed image depicted on the glass.

(*d*) **Myopia.**—The report of Dr. Risley (1881) shows that in Philadelphia, in the primary schools, there is 4.27 per cent. of myopia, that the percentage steadily increases as the pupils pass to higher grades in the public schools, and that in the highest grade there is 19.33 per cent. of myopia. Drs. Loring and Agnew found that in New York City there was 3.5 per cent. in the youngest classes, and 26.78 per cent. in the highest. In Chicago (1886) the range was from 4.09 per cent. in the lowest primary class to 27.08 per cent. in the highest grade in the high school. Dr. Derby (1883) reports, as the results of the examination of four consecutive classes at Amherst (Massachusetts) College, that 34 per cent. out of 254 were myopic at entrance, and 47 per cent. at graduation. In 32 cases the myopia remained stationary, and in 58 cases it increased.

(*e*) **Test** the eyes of the pupils by a set of *Snellen's test-types*. The accompanying test-line is No. X, and should be easily read at ten feet by the normal eye. Some pupils may be able to read it at eleven or more feet distant.

V Z B D F H K O S

(*f*) **Color-Blindness** is an inability of certain persons to distinguish certain colors. The most common form is the inability to distinguish reds and greens from each other. Commonly the color-blind are able to distinguish them in ordinary weather by the intensity of the lights; but in hazy or foggy weather this test often fails them. No color-blind person should be permitted to act as a locomotive-driver, trainman, signal-man, or deck-officer.

CHAPTER XXXVIII.

HEARING.

ANATOMY OF THE ORGANS OF HEARING.

552. The Ear is composed of three parts: (1) the *external* ear; (2) the *middle* ear; (3) the *internal* ear. (Fig. 64.)

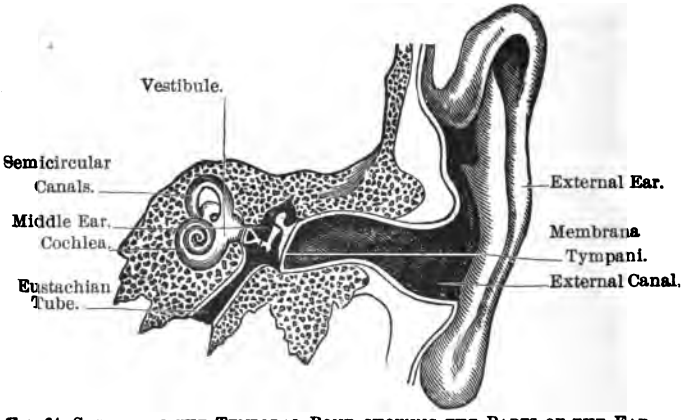

FIG. 64. SECTION OF THE TEMPORAL BONE, SHOWING THE PARTS OF THE EAR.

553. The External Ear presents many ridges and furrows. A funnel-shaped tube extends from the external to the middle ear. (Fig. 64.)

554. The "Drum-head" is a membrane that separates the external from the middle ear. It is called *mem'bra-na tym'pan-i*, or drum-head. (Fig. 64.)

555. The Middle Ear contains three small bones, which

are the most delicate and beautifully-shaped bones in the body. These form a chain from the drum-head to the internal ear. From the middle ear a tube, Eustachian (yu-sta'ke-an), opens into the back part of the throat. (Fig. 64.) If this tube is closed by disease extending from the throat, hearing is impaired.

556. **The Internal Ear** (Fig. 64) has many windings. It is placed deep in the hardest bone of the body (temporal, Fig. 3, [3]). It is made up of a three-cornered cavity, the *ves'ti-bule*, the coiled snail-shell-like passage, the *cochlea* (kok'le-a), and the three *semicircular* canals, named from their shape. The cochlea contains the outer endings of the *nerve of hearing.*

PHYSIOLOGY OF THE ORGANS OF HEARING.

557. **Hearing** is that function by which we obtain a knowledge of sounds (380).

558. *The function of the external ear* is to collect sounds and direct them into the canal. The "drum-head" receives all the impressions of the air which enter the tube, and conveys them to the bones of the ear. The *Eustachian tube* allows air to enter the middle ear from the throat. This keeps the pressure upon the outer and inner surface of the "drum-head" the same.

Observation.—If a person suddenly enters compressed air, as in a "caisson," the drum-head may be forced in, for the person has not had time to get air into the middle ear by the movements of swallowing to compensate for the increased outward pressure.

559. *The chain of bones* carry the vibrations of the "drum-head" accurately to the entrance of the internal ear. The *complicated structures within the cochlea* change these vibrations into hearing impulses. These are conducted to the brain by the *au'di-to-ry nerve.* The *nerve-cells* of certain parts of the brain (Fig. 53) translate the impulses into mental *sensations of sound,* and we hear.

560. The *semicircular canals* appear to be concerned with the sense of position,—the *sense of equilibrium.*

ACTION OF INJURIOUS AGENTS.

561. **Alcohol.**—The experiments of Dr. Scougal indicate that even small doses of alcohol lessen the quickness and the acuteness of hearing. The continuous use of alcoholics in some cases may produce permanent injurious changes in the delicate parts of the middle and internal ears.

562. **Tobacco.** — Excessive smoking, especially of cigars and cigarettes, often causes congestion and catarrh (ka-tar') of the throat (339). Not infrequently this disease-process extends up the Eustachian tube and involves the lining structures of the tube and middle ear (Fig. 64), causing difficulty of hearing.

Observation.—A number of my Japanese patients have had their impaired hearing benefited by ceasing tobacco-smoking.

HYGIENE OF THE ORGANS OF HEARING.

563. *Hearing, like the other senses, is capable of very great improvement.* By cultivation, the blind are enabled to

judge with great accuracy the distance of bodies in motion. The Indian will distinguish sounds that cannot be heard by the white man.

Observation.—A child who is deaf at birth becomes dumb also, for he is unable to hear sounds, and of course cannot imitate them. By careful training of the muscles of the throat and mouth he may be taught to speak.

564. **Precautions.**—After washing the hair, dry it rapidly. During the cold season do not cut the hair close. Avoid exposing the neck or side of the head to cold draughts.

565. Cure diseases of the throat, so that the disease-process shall not extend to the middle ear. Do not use metallic ear-scoops, pins, or knives in the external canal (*a*).

Observation.—The ears of children ought not to be boxed, for the impact of the compressed air may break in the "drum-head."

THE TEN LAWS OF HEALTH.*

566. 1. *Breathe pure air.*
2. *Take wholesome food and drink.*
3. *Take adequate out-door exercise.*
4. *Use adequate and unconstraining coverings for the body.*
5. *Be chaste.*
6. *Live where the climate is adapted to your physical needs.*

* Arranged in order of importance.

7. *Avoid constraining and dangerous occupations.*
8. *Regard personal cleanliness.*
9. *Keep the mind tranquil.*
10. *Avoid marriage with a blood-relation.*

(*J. R. Black, M.D.*)

(*a*) **Defective Hearing** is growing more prevalent in the United States. After scarlet fever the hearing is very frequently impaired. It produces in children an appearance of stupidity. They cannot hear sounds distinctly, and, as a result, cannot imitate sounds accurately. Defects in the teeth of the young are a great cause of deafness. (*Sexton.*) It has been estimated that not more than 5 per cent. of the people of the United States have perfect ears. (*Bell.*) From 20 to 25 per cent. of school-children hear imperfectly. (*Gellé.*) Deaf-mutes should not intermarry. The hearing of school-children and railroad men ought to be tested at regular intervals.

GENERAL REVIEW QUESTIONS.

The Special Senses.

How are nerves classified? (**504.**) How are sensations mentally recognized? (**505.**) What knowledge does touch afford? (**507, 508.**) How is this sense improved or injured? (**509, 510.**) Describe the organ of taste. (**511, 512.**) How is taste excited? How employed? (**513, 514.**) What conditions or agents modify taste? (**515–517.**) Describe the olfactory (smelling) apparatus. (**518, 519.**) What information does smell afford? (**520.**) How may its acuteness be lessened? (**521–523.**)

Sight.

State the facts of structure of the eyeball. (**525.**) Give the anatomy of the eye-membranes. (**526–528.**) Describe the media (humors). (**529–531.**) Name the eye-appendages, and give their uses. (**533, 534.**) Describe the tear-apparatus. (**535, 536.**) Compare the eye with a camera. (**538.**) How is a picture formed on the retina? (**539.**) State the functions of the parts of the eye. (**540.**) How are distant, or near, objects made visible? (**541.**) How should the eye be managed? (**542–544.**) What is essential as regards lamp-light? (**545.**) What care should be taken of the

eyes? (546, 547.) State the causes of, and the management of, near-sight. (548, 549.) How do tobacco and alcohol influence sight? (550, 551.)

Hearing.

Give the anatomy of the external and middle ears. (553–555.) Describe the internal ear. (556.) State the functions of the parts of the external ear. (558.) How do we recognize sounds? (559.) What is the function of the semicircular canals? (560.) How does alcohol affect this sense? (561.) How may tobacco-smoke impair hearing? (562.) How may some ear-diseases be prevented? (563–565.) State the ten laws of health. (566.)

BLACKBOARD ANALYTIC SUMMARY OF THE SPECIAL SENSES.

(Chapters XXXVI.–XXXIX.)

- **Special Sense Mechanism.**
  - An outer nerve-ending.
  - An inward-conducting nerve (sensory).
  - A recognizing group of brain-cells.
- **Touch**
  - *Organ of.* — Nerve-endings in
    - Skin.
    - Tongue.
    - Mucous Membrane.
  - *Use of.* — Recognition of
    - Pain sensations.
    - Tactile sensations.
    - Temperature sensations.
  - *Hygiene of* — Secure a clean, thin skin.
- **Taste.**
  - *Organ of.* — Nerve-endings in tongue and fauces.
  - *Use of.* — Discrimination of flavors.
  - *Hygiene of* — Avoidance of piquant foods.
- **Smell**
  - *Organ of.* — Nerve-endings in nasal passages.
  - *Use of.* — Discrimination of odors.
  - *Hygiene of*
    - Breathe a pure air.
    - Avoid the use of snuffs.

- **SIGHT.**
  - *Organ of*
    - Eyeball.
      - Membranes.
      - Media.
      - Muscle.
    - Optic Nerve.
    - Appendages.
      - Eyebrows, lids, lashes.
      - Tear-apparatus.
      - Muscles.
  - *Use of.* To distinguish external lighted objects.
  - *Hygiene of*
    - Systematic work and rest.
    - Proper illumination.
    - Correction of eye-imperfections.
    - A pure air.
    - Temperance (alcohol, tobacco, food).

- **HEARING.**
  - *Organ of*
    - External Ear.
    - Middle Ear.
    - Internal Ear.
  - *Use of.* Appreciation of sound-vibrations.
  - *Hygiene of*
    - Keep the external ear clean.
    - Prevent nasal and throat catarrhs.
    - Avoid excessive smoking.

APPENDIX.

EMERGENT CASES.

General Hints.—When assistance is needed by an injured person, act *promptly*, *calmly*, and *efficiently*. When other persons are present, if your aid is not needed, withdraw, and take with you all curious persons.

Air and Warmth.—In the first instance, the patient needs air; hence, keep an open space about him. In most cases, warmth is needed; then wrap him in blankets or extra outer clothing.

Drink.—Be sure the patient can swallow before you force much fluid into his mouth and throat. In the majority of cases hot tea, coffee, milk, or hot water, containing pepper or ginger, will suffice. In a few emergencies only are alcoholics needed.

Shock.—This appears after very severe injuries. The patient becomes cold and almost pulseless. The skin appears bloodless and clammy. The breathing may be slow and very gentle, or it may be in gasps. The eyes appear dull; the patient may be partially or fully conscious.

Treatment of Shock.—Slightly raise the limbs and body. Allow free access of air to the face. Place bottles containing hot water, or hot bricks (wrapped in woollen or cotton cloths), or heated sand-bags at the feet and about the limbs and body. Put on extra coverings. Keep the patient quiet for a time before removing him any great distance. Give hot milk or hot water. In extreme cases alcohol may be given.

Bleeding.—Let the person lie quiet. Elevate the cut part. If the gash is small, and the jets of blood small, clean the part with water; press a cloth on the cut a few minutes. Later expose the wound to the air. If the bleeding is not controlled, then apply ice, or water as hot as can be borne.

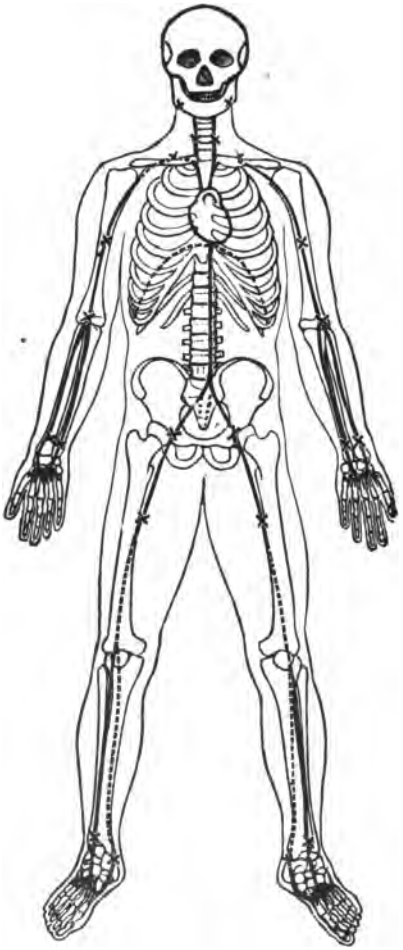

FIG. 65. THE RELATIVE POSITION OF THE MAIN ARTERIES AND THE BONES.—The full lines indicate the superficial course of the arteries; the X X the points most favorable for compression.

If the *cut is large*, and the jets profuse, press one or more fingers on the jetting points *in the wound.* (Fig. 67, C.) Have a bystander knot and twist a strip of cloth, or a handkerchief, and loosely place it around the limb; then twist the knotted cloth with a small stick. (Fig. 66.) Remove the fingers. Give hot milk or coffee, and send for the doctor.

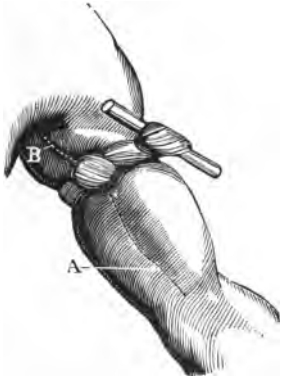

FIG. 66. THE METHOD OF APPLYING THE KNOTTED HANDKERCHIEF TO MAKE COMPRESSION ON THE HUMERAL ARTERY (A, B).

FIG. 67. MANAGEMENT OF BLEEDING.—B, Compressing the subclavian artery. A, Compressing the humeral artery with the fingers. C, Controlling the bleeding by direct finger-pressure on the divided artery in the wound.

The X X (Fig. 65) indicate the points where compression may be made, either by the fingers or the twisted cloth.

Internal Bleeding.—In bleeding *from the nostrils*, sit erect. Do not bend forward. Elevate the arms above the head. Breathe through the mouth. Apply ice to the sides of the nose, to the middle of the forehead, and to the nape of the neck. In excessive bleeding *following teeth-extraction*, fill the cavity in the jaw with plaster-of-Paris paste. In *stomach-bleeding*, accompanied with vomiting, rest on the back, and swallow bits of ice. In bleeding

from the *bowels*, suck ice, and apply ice, wrapped in flannel, to the abdomen. When from the *lungs*, the patient must be kept quiet, and chew ice. In bleeding from the *rectum* or adjacent organs, the hot-water douche (115° to 160° F.) is most efficacious.

Broken Bones.—If the *arm* is injured, support in a sling (made of a handkerchief, two ends tied, and placed around the neck), supporting the arm from the elbow to the wrist. If the *leg* or *thigh* be hurt, bind carefully with handkerchiefs the injured leg to the sound limb.

If the sufferer is to be removed far, carefully cut away the boot and leg garments, gently but firmly pull on the parts below the fracture until the limb reaches its full length. Hold it quietly. Let another person secure some thin strips of shingles, or laths, or straight sticks, or straw cut the length of the limb. Make smooth pads of cloth, and place them above and below the seat of injury, then around the whole adjust the provisional splints, and secure them in place by cords or straps above and below the seat of the breakage. The limb can now be rested on a rude pillow.

An excellent method of removing persons with broken thighs or legs, and in other emergent cases, is to bear them on a door or shutter, suspended by ropes from a stiff pole, borne by two men.

Burns.—When the burn or scald is *small*, apply *cold water* continuously until the smarting ceases. If the burn is *severe*, prick slightly below the blister. Do not pull off the raised skin (epidermis). Apply wet cloths, and keep them wet with a strong solution of *cooking soda*. If soda is not at hand, use strong *soapsuds*. Do not remove the first dressing until the smarting has ceased. When the epidermis comes off at the time of the scalding, quickly cover the denuded surface with wheat flour. In very extensive burns or scalds, put the injured part into a warm bath. Give the patient hot milk, hot tea, or hot coffee. Apply heaters, as in shock. Keep him warm.

Prevention of Drowning.—If you are in danger of drowning, do not attempt to raise your body or hands out of the water. Endeavor to keep the mouth and nose above the water. Lay the hands on a chair, stool, or block of wood, and wait, or with your feet work yourself shoreward.

Drowning Case.—Treat the patient at once on the bank. Do

not lose time by removing him to a house. Remove froth and mucus from the mouth and nose. Raise him by the limbs, so that the water will run from the throat and air-passages. Remove all

FIG. 68. THE SILVESTER METHOD OF ARTIFICIAL RESPIRATION.

FIG. 69. THE SILVESTER METHOD OF ARTIFICIAL RESPIRATION.

close-fitting chest and neck clothing. If natural breathing has stopped, employ the following method:

Silvester Method.—(1st) Lay the patient on the back and slightly elevate the feet and limbs. Put a block under the shoulders, pulling the head well back. (Draw and hold the tongue well out, if possible.) Place yourself at the head; seize the arms above the elbow and draw them upwards until they nearly meet above the head. (Fig. 68.) Then move them back to the side, and press with both hands on the lower part of the breast-bone. (Fig. 69.) Repeat this movement deliberately fourteen times per minute. Persevere for half an hour.

(2d) Dash cold water, or water 120° F. temperature, on the naked chest. As soon as the natural movements of breathing recommence, cease the Silvester movement.

(3d) Maintain the temperature of the body by rubbing (friction), hot baths, and warm blankets. Keep the head in a current of fresh air.

(4th) As soon as the patient can swallow give warm milk, tea, coffee, or, in extreme cases, a little alcohol. Put the patient in a warm bed. Pack hot bottles about him. Encourage sleep. Keep the windows open.

Bodies in the Ear.—Remove vegetable bodies, as beans, etc., as soon as possible. Run a stream of water in at one side of the object, or fill the ear with warm oil, especially in case of insect intruders, to float them out. If these agents fail, make a loop of clean twisted wire; introduce it into the canal along one side of the passage; turn the handle half round; noose the body, and jerk it out.

Dust or Bodies in the Eye.—(1st) Hold the lids open while the eye is rolled up and down or from side to side. (2d) Hold up the upper lid and blow the nose; or (3d) seize the lashes of the upper lid, draw the lid away from the ball, look down, and push the lower lid beneath the upper. (4th) Evert the lid by placing a small pencil on the upper lid, turning up the lid, and removing the dust with a fine cloth on a pencil-point. After the removal of dust or splinter, put in a drop of castor oil to soothe the roughened eye-surfaces.

Fainting.—A faint or swoon is usually brief. Place the person flat on the back. If possible, lower the shoulders and head. Loosen the clothing; cut strings and all tight bands. Apply cold water to the face. Keep a free space about the patient. Apply smelling-salts to the nostrils.

A Fit, as a rule, is not fatal. When a person is struggling, simply prevent him from personal injury. To prevent biting the tongue again and again, place a cork, or a bit of rubber or a

pad of cloth, between the teeth. Loosen the neck and chest apparel. Allow free access of air to the face. It is often well to dash water in the face or on the skin of the chest. When the sufferer revives, allow him to rest quietly many hours. Sleep is the great restorer for the exhausted nerve-force.

Frost-Bite.—The skin first becomes red from congestion of the small blood-vessels; next stage bluish, from arrest of the circulation, and afterwards of a dead-white hue. To restore circulation and sensibility rub the frozen part with snow or apply iced water. Keep the patient at first in a cold room, and let the return to a higher temperature be *gradual* and cautious, else *gangrene* may supervene.

Heat-Stroke is an active febrile condition (103° to 110° F.). It occurs in the overworked and overhurried, especially when the air temperature ranges high. It occurs at night as well as by day. *Treatment.*—Apply cold water and ice to the head. Give ice-water by the mouth and rectum, or cold baths. Alcoholics are hurtful.

Poisoning.—*Act at once, and encourage vomiting.* Give large amounts of tepid water, or tepid mustard-water (one teaspoonful of mustard to a tumbler of tepid water). Tickle the upper part of the throat. If *acids* have been swallowed, give strong soap-suds, soap, whitewash, or chalk; if *alkalies*, dilute vinegar, raw eggs, sweet oil; if *metallic irritants* (corrosive sublimate, arsenic, verdigris, etc.), give freely raw eggs (do not wait to separate the yolks) or milk. After vomiting, in case of *vegetable narcotics* (monkshood, wolfsbane, etc.), enforce rest on the back and give alcoholics. For *opium* or *laudanum* give strong coffee and enforce constant walking. Send for a physician in all cases without delay.

Snake-Bite.—Tie at once a cord or band between the wound and the heart. Cut near the wound, to favor bleeding. If the skin of your mouth is sound, suck the wound; if not, apply a live coal to the bite.

Give *ordinary alcohol* in dessertspoonful doses, or its equivalent in hot water. Add to each dose one grain of quinine and five drops of water of ammonia. Repeat every ten minutes. Continue as long as heart-sustaining effects are produced. With improvement of the patient, gradually increase the intervals of administration. (See ¶ 178.)

Mad-Dog Bites.—Cauterize the wound with lunar caustic (nitrate of silver), or pour into the wound strong acid or alkali. *Do not dose (alcoholics) the person who is bitten.* Endeavor to divert his mind from the occurrence. Do not kill the dog. Keep him securely until unmistakable madness appears, then shoot him. All angry dogs are not mad (rabid).

Sunstroke.—This arises from direct exposure to the sun's rays. In this event there is sudden failure of the heart's action, often ending in speedy death,—the affected person drops as if struck on the head. It is different from "heat-stroke." *Treatment.*—Dash cold water on the head; give the patient plenty of air; administer (as an injection) hot brandy or whiskey, with a little water.

Swallowed Bodies *in the throat.*—If the foreign body can be reached, hook it out of the throat with the middle finger. If this fails, stand the child on its head, and slap the back a few times. If this fails, send in haste for a physician. While waiting for the arrival of the doctor, keep the patient as quiet as possible. *In the stomach.*—If the body is large, tepid water may cause it to be vomited. If the body is small, like seeds or coins, give hard-boiled eggs, cheese, milk, crackers, for several days, that the foreign substance may become lodged in the hardened fæces. Never give a cathartic as a remedy.

Sweating.—It may be necessary to excite free perspiration, as in a sudden chill, in retention of the urine, etc. The *Simpson method* is most excellent:

Fill six or eight bottles with hot water (not much above 150°), and cork tightly. Wring six or eight woollen stockings out of hot water; have them moist, not dripping wet. Draw over each bottle a moist stocking. Pack the encased bottles about the body and legs of the patient. Cover the patient well. In about thirty minutes a thoroughly free perspiration will be effected. Remove the bottles, wrap the patient in a warm blanket, and allow the action to continue half an hour. Remove the damp blanket, and place the patient in a warm, dry bed.

The Sick-Room should be pleasant and light. All carpets and unnecessary furniture and hangings should be removed. It is best to have an open fire. During occupancy it cannot be efficiently fumigated or disinfected; hence it must be thoroughly and constantly ventilated. Powdered charcoal in pans may absorb some of the effluvia, but it is of little value.

In the first stages of disease it is always proper treatment to *rest* both body and mind. A disinclination for food is the warning of Nature that the system cannot

well digest it. In sudden cases of illness no food should be taken until the patient desires food.

Drinks have a more decided influence upon the system than is generally admitted; hence the nurse should never depart from the quality of the drink, nor even exceed the due or prescribed quantity. As a rule, cold water may be given in small amounts at frequent intervals.

The beneficial effects of *bathing* can hardly be overestimated. The best time, however, for daily bathing is when the patient feels most vigorous and is freest from exhaustion. Care is necessary to wipe dry the skin, particularly between the fingers and toes, and also the flexures of the joints. Friction from a brush, a moreen mitten, or a dry flannel that has been saturated with salted water, tends to relieve restlessness in patients. *Open-air-baths* and *sun-baths* have a tranquillizing influence.

Quiet should reign in the sick-room. No more persons should enter or remain in it than the welfare of the patient demands. It is the duty of the physician to direct when visitors should be admitted or excluded, and the nurse should enforce the directions.

A well-adjusted thermometer is indispensable, as the feelings of the patient or nurse are not to be relied on as a true index of the *temperature* of the room. The patient should no more be allowed to complain of *too much heat* without an attempt at its reduction than he should be permitted to remain chilly when a change is possible.

The *nurse* should not confine herself to the sick-room longer than six hours at a time. She should exercise daily in the open air, also eat and sleep as regularly as possible. "Good nursing is half the cure."

Medicines assist the natural powers of the system to remove disease. They should be given regularly, judiciously, and with cheerfulness. Life itself is often at the mercy of the nurse, and depends on the faithful discharge of her duty.

(*a*) **The Excrement and Discharges of the Sick.**—They should be received in an earthen or glass pan containing a few spoonfuls of a solution of chloride of zinc (eight grains to the ounce), or of a saturated solution of permanganate of potassa, or of a solution of corrosive sublimate, 1 part; permanganate of potassa, 50 parts; and water, 1500 parts. These agents control and suppress the odors.

(*b*) **Deodorizers.**—If the above agents are not to be obtained, then use dry black earth, or powdered charcoal, or a strong solution of copperas in the pan and above the excrement. These agents act only to conceal the odors (deodorize). The excrement should be removed at once to the soil-pipe, water-closet, or compost-heap.

(*c*) **Disinfection of the Discharges from Infectious Cases,** as cholera, smallpox, yellow fever, scarlet fever, typhus and typhoid fevers, phthisis pulmonalis, diphtheria, etc. The discharges from the mouth, as well as the bowels, should be received in a pan having one of the above-mentioned solutions (*a*). If possible, burn such excreta. *Fire is the only sure odor- and germ-destroyer.* If they cannot be burnt, then they should be deluged with one of the following watery preparations: Fresh chloride of lime, 1 part in 25; corrosive sublimate, 1 part in 500; crude carbolic acid, 1 part in 20; sulphate of copper, 1 part in 20; chloride of zinc, 1 part in 40. After remaining several hours in such a solution, they should be deeply buried, far removed from the source of water-supply, or cast into the soil-pipe, which should be immediately well flushed.

(*d*) **Vaults and Cesspools.**—Use dry earth and charcoal freely. Scatter a mix-

ture of lime and plaster of Paris—1 part of the former to 9 parts of the latter—freely over the contents daily. Later they should be mixed with the soil, and thus utilized and rendered inactive by soil- and plant-action.

(*e*) **Clothing and Bedding.**—Clothing which has been in contact with the sick may be purified by an hour's boiling. Clothing from the persons suffering from *infectious diseases* ought to be boiled, as soon as removed, in a solution of chloride of zinc (half an ounce to a gallon of water), then thoroughly washed. Bedding and non-washable clothing from infectious patients should be burnt or baked, or exposed to superheated steam for several hours. Furniture and utensils should be several times washed in a solution of carbolic acid and water (1 part to 50), or corrosive sublimate (1 part in 1000).

(*f*) **The Body of the Patient** in an infectious disease should at least be washed daily in a *solution of chlorinated soda*, diluted with 9 parts of water, or carbolic acid (refined), 1 part to 50 of water.

(*g*) **The Body of the Dead.**—Persons dying of infectious disease should be immediately wrapped in a sheet completely saturated with chloride of lime or carbolic or corrosive sublimate solution (*c*). This is to prevent the scattering of the disease-germs. The obsequies over such bodies should be private.

(*h*) **Cremation.**—The bodies of persons dying of infectious diseases are pre-eminently sources of danger to the living. The germs do not lose their vitality on the death of the subject of their operations. They continue to increase, and on the decay contaminate the surroundings of the body. Later they are quite liable to reach some source of water-supply or to enter the air, and thus spread disease anew. Fire is the only sure agent against germs or contagion. Should not the bodies of persons dying of infectious disease be cremated?

(*i*) **Fumigation.**—The sick-room should be fumigated after every case of severe illness and *all* infectious diseases. Vacate the room. Spread out and suspend all bedding, rugs, hangings, etc. (*Sulphur fumigation does some good, but it cannot be relied on as fumigation is commonly done for clothing and bedding.*) Close carefully all openings save one. Place the sulphur in iron pans resting on bricks. Add live coals and leave the room. Keep the room closed for twenty-four hours. Three pounds of sulphur should be burnt for every thousand cubic feet of space. After twenty-four hours the room may be opened. All surfaces should be well washed with corrosive sublimate (1 part corrosive sublimate to 1000 parts of water). The room should be left open and not occupied for several days, preferably for weeks.

PRONOUNCING GLOSSARY.

Ab-do'men. [L. *abdo*, to hide.] That part of the body which lies between the thorax and the bottom of the pelvis.

Ab-sorp'tion. [L. *ab*, and *sorbere*, to suck up.] The process of taking into a vessel or into the system.

Al-bu'men. [L. *albus*, white.] The chief constituent of the white of egg.

Al'co-hol-ism. A series of diseased activities porduced by the use of alcoholics.

Al'ka-loid. A nitrogenous chemical base containing nitrogen.

An-æs-the'sia. [Gr. *an*, against, and *aisthanomai*, I feel.] The absence of sensation, especially of touch.

A-nat'o-my. [Gr. *ana*, through, and *tome*, a cutting.] Dissection.

A-or'ta. [Gr. *aorte;* from *aer*, the air, and *tereo*, to keep.] The great artery that arises from the left ventricle.

Ap'o-plex-y. [Gr. *apoplettein*, to strike with violence.] A sudden escape of fluid into the substance of an organ, as of the brain.

A'que-ous. [L. *aqua*, water.] Pertaining to or like water.

Ar'te-ry. [Gr. *aer*, air, and *tereo*, to keep.] A tube through which blood flows from the heart.

As-phyx'i-a, as-fiks'e-a. [Gr. *a*, without, and *sphyxia*, pulse.] Suspended respiration or apparent death.

Au'di-to-ry. [L. *audio*, to hear.] Pertaining to the sense or organ of hearing.

Au'ri-cle. [L. *auris*, the ear.] A cavity of the heart, which has a dog-ear appendage.

Blis'ter. A collection of serous fluid under the epidermis.

Bron'chi-a, bron'ke-ah, *pl.* Bron'chi-æ. [L.] A division of the trachea.

Bron-chi'tis, bron-kee'tis. [L.] An inflammation of the bronchial mucous membrane.

Cap'il-la-ry. [L. *capillus*, a hair.] Resembling a hair; a small tube.

Car'bon Com'pounds. Chemical compounds whose base is carbon.

Car-bon'ic Ac'id. A gas produced by perfect combustion of carbon in oxygen.

Car'ti-lage. A pearly-white, elastic substance found adherent to bones.

Ca-tarrh', ka-tar'. [Gr. *katarreo*, to flow down.] A profuse mucous secretion.

Cell. The anatomical unit.

Cer-e-bel'lum, ser-e-bel'lum. [L.] The little brain.

Cer'e-brum. [L.] The front brain.

Chest. [Sax.] The thorax.

Chlo'ral, klo'ral. [*Chlor*, the first syllable of chlorine, and *al*, the first syllable of alcohol.] A hypnotic.

Chlo'ral-ism. The condition resulting from using chloral.

Cho-roi'de-a, ko-roi'de-ah. [Gr. *chorion*, skin.] The second tunic of the eyeball.

Cir-cu-la'tion. [L. *circulatio*, a going round.] The name given to the motion of the blood through the different vessels.

Cir-rho'sis, sir-ro'sis. A hardening and contraction of an organ.

Clot. [Dut. *klut*, a mass or lump.] A concretion of stagnant blood.

Co-ag-u-la'tion. [L. *coagulo*, to curdle.] The process of producing a thickened state in albuminoid fluids.

Coch'le-a. [Gr. *kochlo*, to twist; or L. *cochlea*, a screw.] A cavity of the ear resembling in form a snail-shell.

Com-bus'tion. [L. *combustio*, a burning.] Burning.

Con-junc-ti'va. [L. *con*, together, and *jungo*, to join.] The membrane that covers the front of the eyeball.

Con-sump'tion. [L. *consumo*, to waste away.] Phthisis of the lungs.

Con-vul'sion. [L. *convello*, to pull together.] Violent agitation of the limbs or body.

Cor'ne-a. [L. *cornu*, a horn.] The transparent membrane in the fore part of the eye.

Cor'pus-cle. [Dim. of L. *corpus*, a body.] A small body, as a blood-disk.

Cos-met'ics. [Gr. *cosmeo*, to adorn.] Medicines supposed to beautify and improve the complexion.

De-gen-er-a'tion. [L. *degenero*, to be worse than one's ancestors.] A diseased change in the structure.

Der'mis. [L. *derma*, the skin.] The inner layer of the skin.

Di'a-phragm, di'a-fram. [Gr. *diaphragma*, a partition.] The midriff.

Di-ar-rhœ'a, di-ar-re'ah. [Gr. *diarrheo*, to flow through.] A morbidly frequent evacuation of the intestines.

Di-ges'tion, di-jes'tshun. [L. *dis*, apart, and *gero*, to bear.] The process of preparing foods in the alimentary canal.

Diph-the'ri-a, dif-the'ree-ah. [Gr. *diphthera*, a membrane.] A systemic disease with local membrane-formation in the throat or larynx.

Dip-so-ma'ni-a. [Gr. *dipso*, thirst, and *mania*, madness.] An insatiable desire for intoxicants.

Duct. [L. *duco*, *ductum*.] A tube or canal in the body.

Dys-pep'si-a, dis-pep'se-ah. [Gr. *dus*, and *peplo*, to digest.] Indigestion.

En-am'el. The smooth, hard substance which covers the crown of a tooth.

Ep-i-dem'ic. [Gr. *epi*, upon, and *demos*, the people.] An extensively prevalent disease.

Ep-i-der'mis. [Gr. *epi*, upon, and *derma*, the skin.] The cuticle.

Ep-i-glot'tis. [Gr. *epi*, upon, and *glotta*, the tongue.] A cartilage of the larynx.

Eu-sta'chi-an (yu-sta'ke-an) **Tube.** A channel from the throat to the middle ear, named from Eustachius.

Ex-cre'ta. [L. *excerno*, to separate.] Matter excreted; alvine discharges.

Ex-cre'tion. [L. *excerno*, *excretum*, to sift out.] The process of separation of effete materials.

Ex-pi-ra'tion. [L. *expiro*, *expiratum*, to breathe forth.] The act of expelling air from the air-passages.

Fats. Vegetable and animal oils. They are mostly hydro-carbons.

Fer-men-ta'tion. [L. *fermento*, to leaven.] The spontaneous changes which watery solutions or organic matter undergo under atmospheric influences.

Fe'ver. A condition characterized by continued elevation of the body-temperature, with disordered functions.

Fi'bre. [L. *fibra*.] An organic filament or thread.

Fil-tra'tion. Straining.

Func'tion. [L. *fungor*, to perform.] The appropriate action of an organ.

Gan'gli-on, *pl.* **Gan'gli-a.** [Gr. a knot.] A collection of gray nerve-cells.

Gas'tric. [Gr. *gaster*, the stomach.] Belonging to the stomach.

Germ. The rudiment of a new being.

Gland. [L. *glans*, an acorn.] An organ whose function it is to secrete or separate some particular fluid from the blood.

Glot'tis. [Gr.] The narrow opening at the upper part of the larynx.

Glyc'o-gen, glik'o-jen. [Gr. *glukus*, sweet,

and *gennao*, to engender.] A substance made in the liver. It readily changes to sugar. It is used to feed the working tissues.

Gout. Inflammation characterized by pain in the joints of the feet and hands.

Hem'or-rhage. [Gr. *haima*, blood, and *regnumi*, to burst.] A discharge of blood.

He-red'i-ty. The predisposition or tendency to definite physiological actions derived from one's ancestors.

Hy'gi-ene, hi'jī-ēn. [Gr. *hugieia*, health.] That branch of medical science which treats of the preservation of health.

Hyp-not'ics, hĭp-not'iks. [Gr. *hupnos*, sleep.] Drugs having the power to induce sleep.

Im'pulse. That which passes over the nerve-fibres from nerve-cell group to nerve-cell group.

In-flam-ma'tion. [L. *inflammo, inflammatum*, to set on fire.] A disordered function, characterized by pain, heat, redness, and swelling.

In-spi-ra'tion. [L. *in*, in, and *spiro, spiratum*, to breathe.] The act of drawing in the breath.

In-tes'tines. [L. *intus*, within.] The canal that extends from the stomach through the body.

In-tox'i-cant. [L. *in*, in, and *toxicum*, poison.] A substance which will induce drunkenness or inebriety.

In-vol'un-ta-ry. Independent of the will or power of choice.

I'ris. [L. the rainbow.] The colored circle that surrounds the pupil.

Lac'te-al. [L. *lac*, milk.] A small vessel or tube of animal bodies for conveying chyle from the intestines to the thoracic duct.

Lar'ynx, lar'inks. [Gr. *larunx*.] The upper part of the windpipe. The organ of the voice.

Lig'a-ment. [L. *ligo*, to bind.] A strong, compact substance serving to bind one bone to another.

Lymph, limf. [L. *lympha*, water.] A colorless fluid.

Lym-phat'ic, lim-fat'ik. A vessel of animal bodies that conveys lymph.

Ma-la'ri-a. [Ital. *mala*, bad, and *aria*, air.] The disease-inducing agents arising from decaying organic materials.

Me-dul'la Ob-lon-ga'ta. The commencement of the spinal cord.

Mi'cro-scope. [Gr. *mikros*, small, and *skopeo*, to look at.] An optical instrument employed in the study of minute objects.

Mor'phi-a, mor'fe-ah. [From *Morpheus*, the god of sleep.] The most important narcotic principle of opium.

Mu'cus, mu'kus. A viscid fluid secreted by the mucous membrane.

My-op'ic. [Gr. *muo*, to contract, and *ops*, the eye.] (Near-sighted persons partially close the eyes when looking at distant objects.) Relating to near-sight.

Nar-cot'ic. [Gr, *narke*, stupor.] A medicine which induces stupor or sleep.

Na'sal. Relating to the nose.

Nerve. A fibre of the animal body which transmits impulses.

Nerve'-Cen-tre. A group of nerve-cells.

Ner'vous-ness. Unusual impressibility of the brain-centres; "brain-fag."

Neu-ral'gi-a, nū-ral'jee-ah. [Gr. *neuron*, a nerve, and *algos*, pain.] Pain in the course of a nerve.

Nic'o-tin, or **Nic'o-tine,** nik'o-teen. The colorless, poisonous, and stupefying odorous oil extracted from tobacco.

Nu-tri'tion. [L. *nutrio, nutritum*, to nourish.] The act of nourishing.

Œ-soph'a-gus. [Gr. *oio*, to carry, and *phago*, to eat.] The passage from the mouth to the stomach.

Ol-fac'to-ry. [L. *oleo*, to smell, and *facio*, to make.] Pertaining to smelling. The first pair of cranial nerves.

O'pi-um. [Gr. *opos*, juice.] The concrete juice of the *Papaver somniferum*.

Ox-i-da'tion. The chemical union of oxygen with other substances.

Pan'cre-as. [Gr. *pan*, all, and *kreas*, flesh.] The sweet-bread.

Pa-pil'la, *pl.* **Pa-pil'læ.** [L.] Small conical prominences.

Pa-ral'y-sis. Abolition of function, whether of intellect, sensation, or motion.

Pa-rot'id. [Gr. *para*, near, and *otos*, genitive of *ous*, the ear.] A salivary gland.

Pel'vis. [L.] The basin formed by bones at the lower part of the abdomen.

Pep'sin. [Gr. *pepto*, to cook.] An ingredient of the gastric juice which acts as a ferment in the digestion of the food.

Per-i-car'di-um. [Gr. *peri*, around, and *kardia*, the heart.] A membrane that invests the heart.

Per-i-os'te-um. [Gr. *peri*, around, and *osteon*, a bone.] The white membrane investing the bone.

Per-i-te-ne'um. [Gr. *peri*, around, and *teinein*, to stretch.] A thin, serous membrane investing the internal surface of the abdomen.

Per-spi-ra'tion. [L. *per*, through, and *spiro*, to breathe.] Excretion by the skin.

Phar'ynx, far'inks. [Gr. *pharunx*.] The upper part of the œsophagus.

Phthi'sis, ti'sis. [Gr. *phthio*, to consume.] Pulmonary consumption.

Phys-i-ol'o-gy, fiz-e-ol'o-je. [Gr. *physis*, nature, and *logos*, a discourse.] The science of the functions of the organs of animals and plants.

Plas'ma. [Gr. *plasso*, to form.] The fluid in which the blood-corpuscles float.

Pleu'ra, plu'rah, *pl.* **Pleu'ræ.** [Gr. *pleura*, the side.] A thin membrane that covers the inside of the thorax and also forms the exterior coat of the lungs.

Pons. [L.] A bridge. A part of the brain.

Por'tal. [L. *porta*, a gate.] Relating to the vessels entering the liver.

Pro'te-ids. [From *Proteus*, who could assume different shapes.] A class of complex chemical compounds containing nitrogen, sulphur, etc., made exclusively by plants.

Pul'mo-na-ry. [L. *pulmo*, the lungs.] Belonging or relating to the lungs.

Pulse. [L. *pello*, *pulsum*, to beat, to strike.] The beating of the arteries following the contraction of the heart-muscle.

Pu'pil. A little aperture in the centre of the iris.

Py-lo'rus. [Gr. *puloros*, a gate-keeper.] The lower orifice of the stomach.

Rec'tum. The third and last portion of the intestines.

Re'flex Ac'tion. A term applied to certain movements executed independently of the will.

Re-pro-duc'tion. [L. *re*, again, and *produco*, *productum*, to bring forth.] The production by organized bodies of others similar to themselves.

Res-pi-ra'tion. [L. *re*, again, and *spiro*, to breathe.] The act of breathing.

Ret'i-na. [L. *rete*, a net.] The essential organ of sight.

Sa-li'va. [L.] The fluid secreted by the salivary glands.

Scle-rot'i-ca. [Gr. *skleros*, hard.] One of the tunics of the eyeball.

Se-cre'tion. The act of producing from the blood substances different from the blood itself.

Selt'zer. Water impregnated with carbonic acid gas; soda-water.

Sen-sa'tion. The consciousness of the reception of an impulse.

Se'rum. [L.] The thin, transparent part of the blood.

Sew'er-Gas. The complex gases developed by decomposition of organic materials in sewers and cesspools.

Skel'e-ton. [Gr. *skello*, to dry.] The aggregate of the bones of the body.

Soft Water. A water which readily yields a lather with soap.

Soil-Pipe. The pipe into which the water-closet basin empties.

Spi'nal Cord. A prolongation of the brain.

Spir'its. The term is confined to the stronger alcoholic beverages, such as rum, gin, whiskey, brandy, etc.

Ster'num. The breast-bone.

Stim'u-lant. A drug which excites the organic action of the animal system.

Sy-no'vi-a. [Gr. *sun*, with, and *oon*, an egg.] The fluid secreted into the cavities of joints.

Tem'per-a-ture. A certain degree of heat, as measured by a thermometer.

Tem'po-ral. [L. *tempus*, time.] Pertaining to the region of the temple.

Ten'don. [Gr. *teino*, to stretch.] A hard insensible cord, or bundle of fibres.

Tho-ra'cic Duct. The princ'pal tube of the lymphatic system.

Tho'rax. [Gr.] The cavity of the chest.

Tis'sue. The texture of parts.

Ton'sil. [L.] A glandular body in the throat or fauces.

Tour'ni-quet, tŭr'ni-ket. A band to check bleeding.

Tra'che-a, tra'ke-ah. [Gr. *trachus*, rough.] The windpipe.

Tri-chi'næ (tre-ki'ne) **Spi-ra'lis.** A species of minute worms which work their way through human muscles, causing pain, irritation, and exhaustion.

Ty'phoid (ti'foid) **Fe'ver.** [Gr. *tuphos*, stupor, and *eidos*, form.] A fever resembling typhus, but having intestinal lesions.

U-re'a. A nitrogenous waste found in the urine.

U-re'ter. [Gr. *ourein*, to conduct water.] The excretory duct of the kidneys.

Vac'cine (vak'sin) **Vi'rus.** [L. *vacca*, a cow, and *virus*, poison.] The material derived from heifers for the purpose of vaccination.

Valve. A membrane which prevents fluids from flowing back into the vessels.

Veins. Vessels that convey blood *to* the heart.

Ven-ti-la'tion. [L. *ventilo*, *ventilatum*, to blow, or to fan.] The operation of causing the air to pass through any place for the purpose of expelling impure air.

Ven'tri-cle. [L. *venter*, the stomach.] A cavity of the heart.

Ver'te-bra, *pl.* **Ver'te-bræ.** [L. *verto*, to turn.] A joint of the spinal column.

Vit're-ous. [L. *vitrum*, glass.] A humor of the eye.

Vo'cal. [L. *vox*, the voice.] Uttered by the voice.

Vo-li'tion. [L. *volo*, *volitum*, to desire.] The act of willing or of choosing.

Vol'un-ta-ry. [L. *voluntas*, the will.] Acting in obedience to the will.

Will. The faculty or power of choosing to do or not to do, to act or not to act.

Wrist'-Drop. Loss of power in the muscles of the forearm in lead-poisoning.

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THE END

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NAME	DATE	NAME	DATE
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